MACHINERY.

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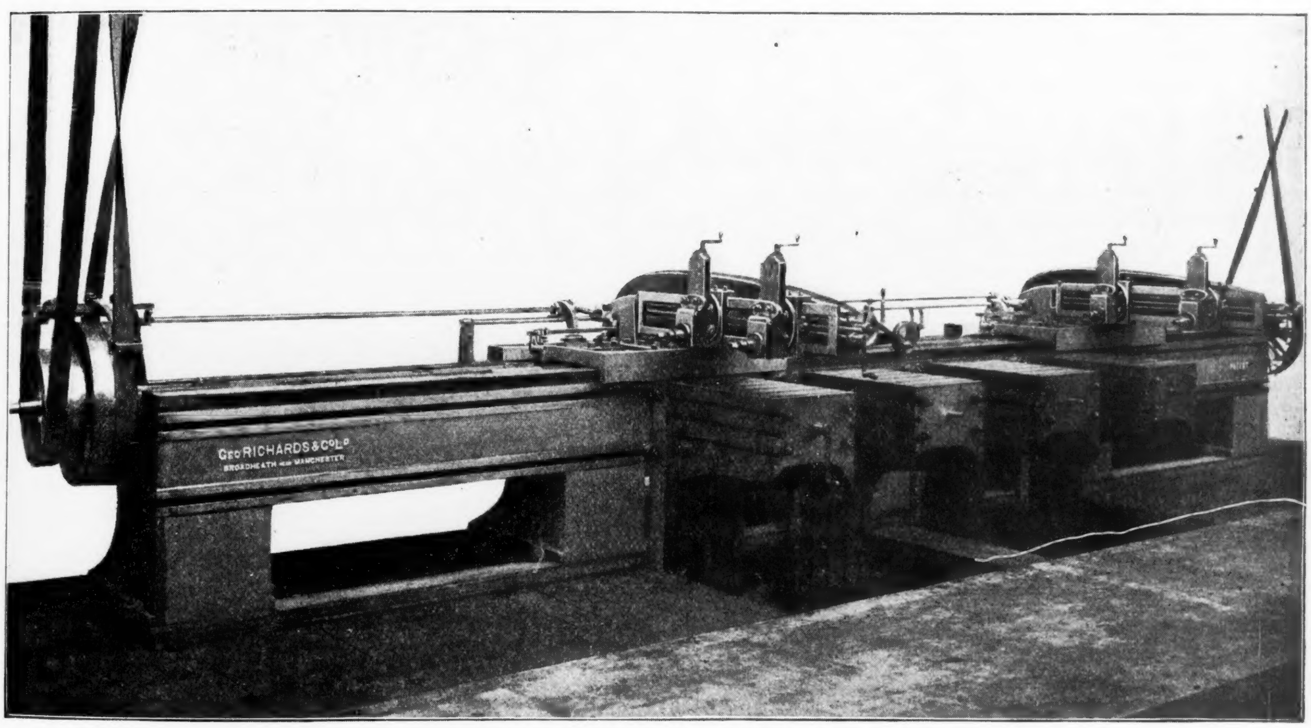
A MANCHESTER WORKS AND ITS PRODUCTS.

JAMES VOSE.

Having occasion to visit the works of Messrs. Geo. Richards & Co., Ltd., Broadheath, Manchester, Eng., I had the opportunity of inspecting a newly-finished side planer, which would appear to be the largest yet built, in Europe at any rate. The shop in which it had been erected, has only recently left the builders' hands, but it promises to be a useful addition to an already well-laid out works. The only shop tool then at work in this extension was a Sellers planer, capable of planing a length of 35′ by 36″ square. A long side planer bed was being operated on, both cross-rail tool boxes being at work removing a cut from 3/8″ to 5/8″ deep, and as the Mushet steel tools were particularly well ground, as regards shape and cutting angle, it was a pleasure to watch the chips curling away from the casting. Two powerful travelling cranes, pending the arrival of their electrical driving gear, were being worked by hand, manipulating the heavy castings dealt with by the Sellers planer and the erecting floor hands.

very efficient and productive pulley-boring machine, designed on unconventional lines by Mr. Geo. Richards.

The adjustable swivelling hangers and pedestals, and the split pulleys, which have cast iron arms and hubs and steel rims, commend themselves to the eye of the mechanic, and their design shows unmistakable traces of that instinct, or faculty, of designing as distinct from inventing, recently mentioned by Professor Sweet in his address at the opening of the session of a trades school. The mean appears to have been arrived at between the, at first sight, fragile hangers used in America—but which I have never known fail to answer their purpose—and the extremely substantial fixtures made in the past by eminent English firms for carrying fixed bearings. In consequence of the present extensive additions to motive power plants in all classes of business, the carrying on of this branch is no sinecure. The wood-working machinery manufactured by Messrs. Richards & Co. includes very efficient types of band and circular saws, planing



A Large Side Planer.

Before proceeding further with the description of the side planer, it might not be out of place to give a general description of the works and its output. These works, now covering nearly four acres of ground, were the pioneers in a district about five miles out of Manchester, and owe many of their characteristic features, as regards construction and products, to the organizing and designing abilities of Mr. Geo. Richards, who, for a number of years, was prominently identified with the firm. They are well situated as regards railway and canal facilities. The Bridgewater canal—the first carried out by Bundley, "the father of inland navigation"—passes close to the works, and a railway siding connected to the shipping department enables goods to be delivered to all the principal railways, and also saves much handling of raw material. One flourishing section of the works is the power-transmission department. This is entirely separate from the wood-working machinery and tool-building departments, and it is self-contained in every particular. Its equipment includes a

machines and special tools for pattern shop use. In the metal-working machine tool lines, the various machines have distinctly characteristic features, and the number of types occupies a position about midway between those produced by extremely specialized American tool works and a reputable English concern building lines ranging from powerful hydraulic tools to projectiles and special textile machinery.

Electrical driving is adopted here, the tools being driven in groups from line shafting, each line shaft working from its own motor. Their own installation of machine tools includes examples of their own lines, other representative English tool builders, and some of the latest American productions, including Brown & Sharpe milling and gear-cutting machinery, Gleason bevel-gear planers, Colburn key-seaters, etc. Somewhat of a novelty is the gap-bed lathe, manufactured by the American Tool Works Co. I was informed that, on the general run of work, the gap-beds had not proved disadvantageous, but were, during the

present rush of work, of material assistance on occasion. Returning to the 48" side planer, as will be seen from the illustration, it is fitted with two overhanging arms. Each arm is operated by an independent screw, driven from its own countershaft. These screws are of ample diameter and are fitted with special thrust collars. Each of the arms will plane a width of 48", and a length of 20' when one of the arms is stationed at the extreme end of the bed. Both arms may be working simultaneously, providing the total length of stroke does not exceed 20'. Two tool boxes are provided on each arm, each having automatic cross and down feeds, and being arranged for planing angles. I might here point out that, in common with many English firms, Messrs. Richards make provision for taking up wear on the pin on which the tool rest or clapper box swivels. I have not seen this feature on any American shaper or planer. It would be interesting to know the reason for this omission.

Four tables are provided for holding the work. It will easily be seen that the machine is capable of dealing with a wide range of work as, to quote the firm's description: "Four cuts can simultaneously be taken off one casting, or two cuts off two separate castings, or four separate rows of small castings can be planed at the same time." The belt shipping and feed arrangements are brought well up to date, and the tool altogether appears likely to prove a most useful addition to the range of sizes in which the side planer is built.

Chatting on general topics, the American system of working hours is in use in these works, and is apparently found advantageous by the firm. Personally, I have no experience of the merits of the system, but have never heard it spoken of enthusiastically by English workmen. A system of piece work is also in vogue, and appears to give mutual satisfaction, no reduction in the piece-work rates having been made for many years. The beneficial effects of this last feature were commented on by Mr. Matthewson, the managing director of the works, in the course of some remarks addressed to a deputation representing the staff and employees, who wished to convey to the directors their appreciation of the hospitality extended to them and their families on July 3, 1899. This token of good feeling manifested by the firm to its employees took the shape of a well planned picnic attended by about 1,000 participants. The speaker considered that much of trades union opposition to piece work and kindred systems had probably arisen through ill-considered and uncalled for cutting of piece-work rates by more or less shortsighted employers in the past. As American interests are well represented on the management of the concern, the workmen requested and obtained a holiday on the day following the outing, so that in one case at least, the 4th of July was duly celebrated by British workmen. In conclusion, it may be added that, at the present time, extensive additions to the buildings and plant are in contemplation, and will probably be taken in hand shortly.

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It is generally recognized that as mankind advances in intelligence and experience he does pretty much the same things at the same stages of development the world over, although, perhaps, in a little different way. And so it is, we suppose, that we received at nearly the same time accounts of two actual instances where two different would-be or hope-to-be mechanics used a ladder in lacing a belt and laced the belt through the ladder so that the job had to be repeated. One of these accounts was related of our friend Jones, of Jones Engineering Company fame, and the other is told of by our new contributor, "Junius," in this number of the paper.

* * *

The scale on cast iron is very hard on the cutting edges of lathe tools and milling cutters and the endeavor is always to cut at sufficient depths to get beneath the scale. If the castings have so little stock that it is not possible to do this, the abrasive action of the scale can be overcome by "pickling" the castings in a solution of diluted sulphuric acid.

NOTES FROM THE SECOR WORKS

AN OIL ENGINE FOR DIRECT DRIVING—ENGINE DETAILS—A NOVEL METHOD OF BALANCING.

The Secor oil engine was illustrated and briefly described in the May, 1899, issue of MACHINERY, and in Fig. 1 the same type of engine is shown directly connected to a lighting dynamo without the interposition of a flexible coupling, which is usually necessary on internal combustion motors.

The Secor engine is an oil engine operating in the Otto cycle, but with the governing accomplished by the regulation of the amount of charge fired and not by the hit-and-miss plan. Thus a charge of a quantity that depends entirely on the amount of

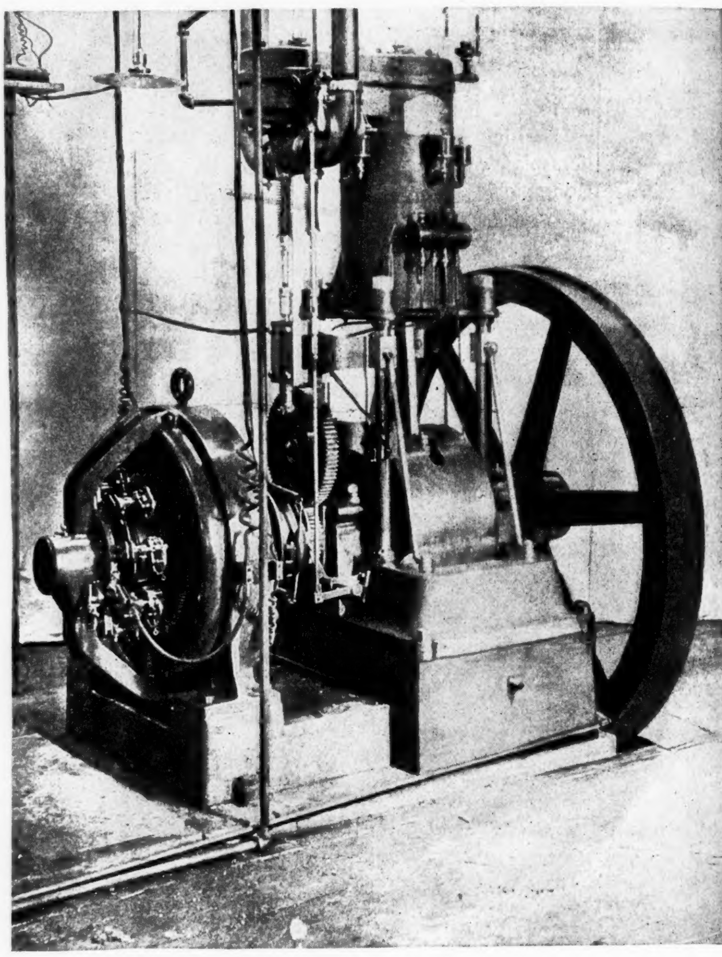

Fig. 1. Direct Connected Oil Engine and Dynamo.

work being done is fired at every other down stroke of the piston. The regulation obtained approaches that obtained in the best high-speed steam engines and is effected by a micrometric measuring device, controlled by a shaft governor, for exactly fixing the amount of oil and air to the requirements of the load.

That this system of governing is quite efficient was recently shown to the writer while at the Secor Works, in Brooklyn, N. Y. The engine and dynamo shown in Fig. 1 are run at a speed of about 350 turns per minute, and, as before stated, the shaft connection between the two is absolutely rigid. With a load of 100 incandescent lamps, the voltage remained perfectly constant, and when this load was thrown off or on, the deflection of the voltmeter was not more than two or three volts. As the efficiency of the dynamo was rated rather low, the power delivered by the engine was probably about 10 H. P., which is a fair load for this size of engine. The switchboard was so arranged that 65 additional lights could be thrown in on the same circuit. When this was done, there was, of course, a heavy overload, but the regulation of the engine was such that the voltage did not drop more than four or five volts from the standard. When it is considered that the engine is a single cylinder and that a charge is fired at only every other revolution or an impulse given only one-quarter as many times for the same rate of rotation as would be the case with a steam engine, it will be seen that the perform-

ance witnessed is quite unusual. Of course a heavy fly-wheel is used, but, it is said, not as heavy as those usually put on internal combustion motors of the same or less power.

As will be seen, this engine is of peculiar construction, the uprights supporting the cylinder being merely steel tie-rods braced by the diagonal stays at the sides. This construction favors in-

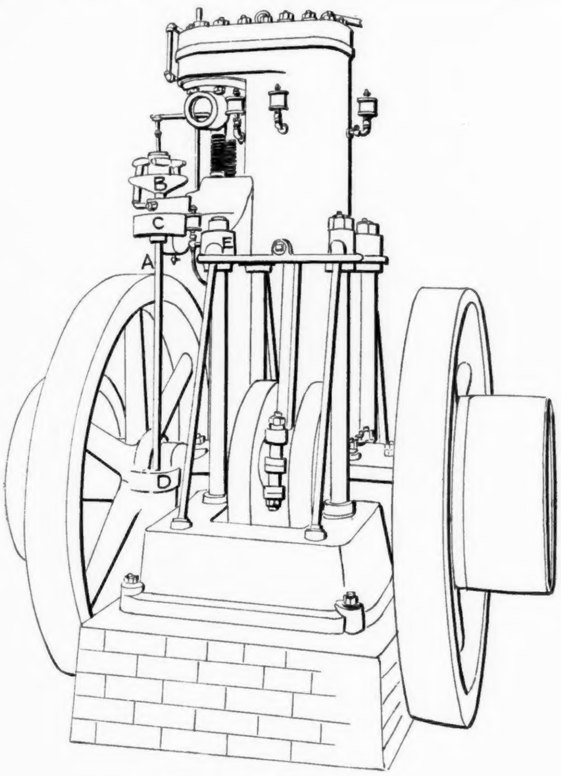

Fig. 2. New Type Engine.

spection of parts and makes a lighter engine for the same strength than would be the case if cast iron was used throughout.

A new model has recently been designed in which the construction and mechanical arrangement are somewhat changed, as will be seen from Fig 2. The diagonal stays are connected to the cylinder casting at E instead of to the sides of the tie-rods, as in

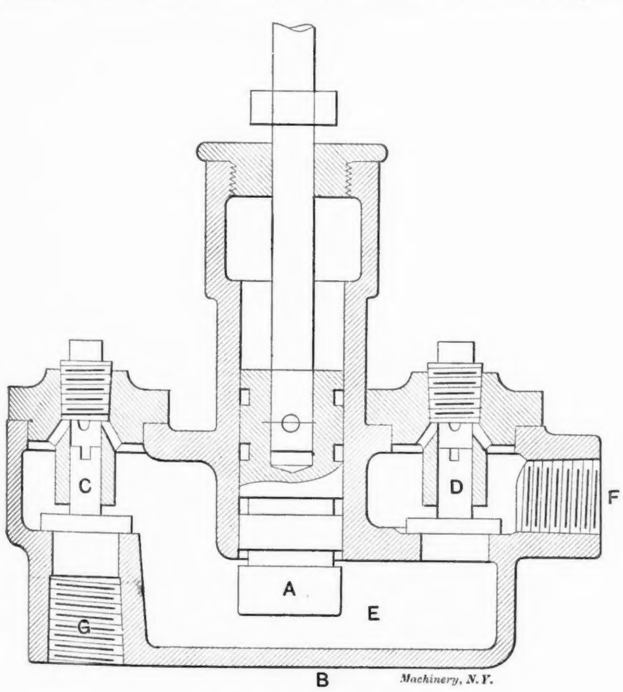

Fig. 3. Details of Pump.

Fig. 1. The operation of the valve-gear is effected through spiral gearing. The vertical shaft A is driven directly from the engine shaft by the spiral gears inclosed in the case marked D. The governor of this engine is at B instead of on the engine shaft. The vertical shaft A gears into a horizontal shaft at C which carries the cams operating the inlet and exhaust valve. On this engine the gravity feed apparatus is replaced by a pump and suction charging device. While the gravity feed apparatus has always proved eminently satisfactory when the engine is operated by competent attendants, there is the danger of flooding the cylinder and thereby causing destruction by fire. To meet the requirements of the insurance underwriters, the pump and suction feed apparatus has been developed.

The pump is shown at Fig. 3 and is of very simple construction. The plunger A works freely in its cylinder and has no packing beyond that furnished by the grooves shown, which operate in the same manner with oil as with grooves cut in pistons for the so-called "water packing." No packing is used around the piston-rod and in fact no attempt is made to secure any very close working fits. The inlet valve is at C and the outlet valve is at D, the oil, as it pumped, circulating through the chamber E. The reason that such a simple and obviously leaky construction can be used, kerosene being one of the most penetrating liquids known, is that the pump is made to have a capacity of four or five times that required, the surplus pumped being allowed to overflow from the small reservoir from which the cylinder is charged, and return to the tank. Since the capacity of the small reservoir referred to is that of a small glass oil cup, it is obvious that a dangerous quantity of oil cannot be introduced into the cylinder.

A point in the construction of the connecting-rod brasses on the new type of engine is worth noting. The connecting-rod is made in the form of the well known marine type, but the bolts holding the brasses are somewhat different from those

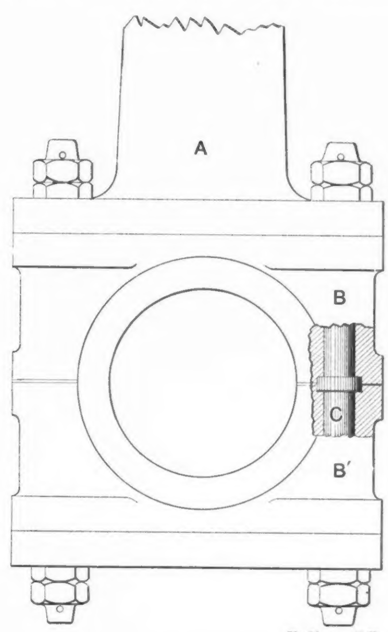

Fig. 4. Connecting-rod Details.

usually employed. Instead of having a head at one end, nuts are used at both ends and the bolt has a collar in the middle, as shown at C, Fig. 4. The object of this construction is to enable the brasses to be slightly slacked, if demanded, by a warm crank-pin without necessarily loosening the bolts and both brasses, thereby causing them to wear and become shaky. Another good feature is that the lower brass B can be removed without loosening the upper brass B, or without being troubled with its dropping down when removing the lower brass, as is the case ordinarily.

The pistons of oil or gas engines are usually a problem in that it is quite difficult to make them so that they will stay tight. The conditions under which they operate seem to be specially trying in this direction. Probably one reason for the trouble is the universal employment of the trunk piston on this type of engine, which also acts as a cross-head and thus tends to wear the cylinder elliptical in section and not uniformly throughout its length. The piston and piston packing of the Secor engine are shown at Fig. 5. The rings are made eccentric, that is, with the portion opposite the cut somewhat thicker than at the opening. After being cut and beveled, they are sprung together and

turned to exactly fit the cylinder. To avoid distorting them to get them in the grooves of the cylinder, as would be the case if sprung in in the usual way, the piston is made so that the rings may be put on from the end and still be in separate grooves. The bull-rings C C are made with one-half the groove for the packing rings B B B in each, and when assembled on the piston they present three complete grooves. The insertion of the packing rings is, therefore, only a simple matter of removing the

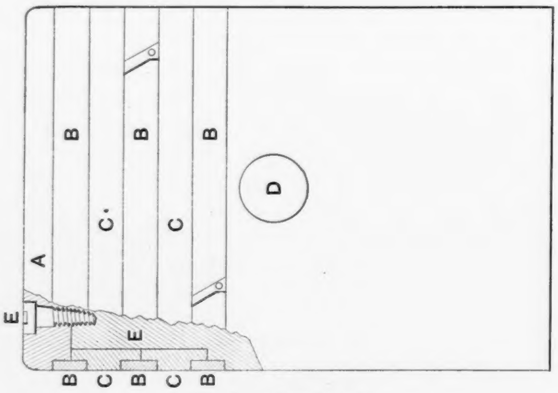

Fig. 5. Piston Details.

follower plate A which is held in place by four filister head screws, and the bull-rings, to be replaced in order with the packings between.

The development of a practical motor for automobiles is a problem that is of tremendous difficulty, the conditions being such that a successful motor must contain a number of features unnecessary in ordinary stationary or marine practice. One of these features is to be perfectly free from vibration. To balance an ordinary reciprocating one-cylinder engine so as to eliminate vibration when not fastened to a foundation, is practically impossible, as action and reaction in all directions cannot be balanced.

Mr. Secor has designed an oil engine working on the reciprocating principle, which, however, overcomes the difficulties of balancing incident to the ordinary type. It is not an ordinary engine, as will be seen by reference to Fig. 6. The principle on which it operates is likened to that which would take place in a

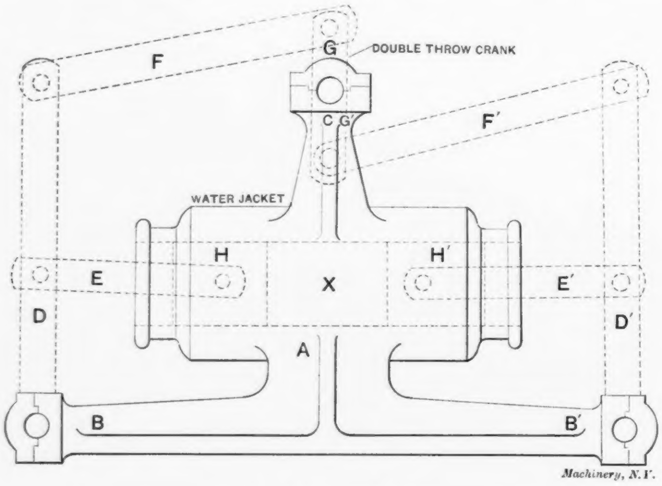

Fig. 6. A Balanced Engine.

cannon having no breech if it were loaded in the middle with a charge of powder between two projectiles. If the projectiles were of equal weight and had the same frictional resistance in the barrel of the gun, action and reaction would be equal between them and both would be projected an equal distance while the reaction or "kick" of the cannon would be nothing. Working on this principle, the motor roughly outlined in Fig. 6 is to be developed. The charge is to be fired in the chamber X between the two pistons H H′, whose motion is transmitted to the cranks G G′, having equal throw and set at 180° apart on the crankshaft.

The pistons are connected by the short connecting-rods H H′ to the vertical levers D D′, which transmit motion to the cranks through the connecting-rods F F′.

It will readily be seen that action and reaction are absorbed by pistons traveling in opposite directions and at the same speed and also that parts like connecting-rods, whose movement is complex and difficult to balance, are here balanced by a similar part moving in an exactly opposite direction.

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A writer in London "Engineering" states that American and English manufacturers exhibit a marked difference in their willingness to impart information. The American will, as a rule, not hesitate to take any one through his works and show him any novel methods that he may have adopted. English and Continental manufacturers, however, do not thus open their works to the public and are not anxious to supply information to the public. In commenting on this, a writer in the "Engineering Magazine" says, that the generally accepted European idea is undoubtedly that secrecy is the key to success in manufacturing, and adds, "Is it not true, moreover, that this system tends to preserve and perpetuate methods and machines which have elsewhere been discarded as obsolete? A few years ago an American visitor to some English establishment was surprised at the difficulty he experienced in obtaining access to workshops, and still more surprised and amused to find, eventually, that the carefully guarded machines and processes of manufacture would have been considered quite out of date in his own country." To this it may be said that it is not necessary to go to England to experience this condition of affairs.

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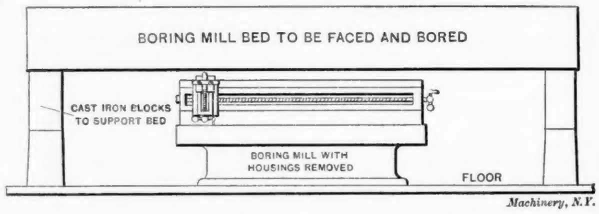
AN AWKWARD JOB.

A boring mill is being built by William Sellers & Co. with non-adjustable housings that will swing work 28′ in diameter.

To bore the hole for the table spindle and face the circular bearing was something of a problem, as there is no tool in the shop large enough to handle such a piece. The way the bed was machined is indicated in the sketch. The housings of a boring mill were taken down, leaving the table with its driving mechanism in place. The bed of the large mill was then "chucked" over



Milling a Large Boring Mill Bed on a Smaller Mill.

it and with its top down. The hole was bored by a fixture bolted to the table, which had a traveling head. The circular bearing was machined by the rig shown which is a special cross-rail bolted to the table and carrying a tool slide.

The bed was held up by the cast-iron blocks shown at the corners. In this manner, the bed weighing many tons was bored and faced without much difficulty. Such a feat would, however, be difficult if not practically impossible in a shop not equipped with traveling cranes.

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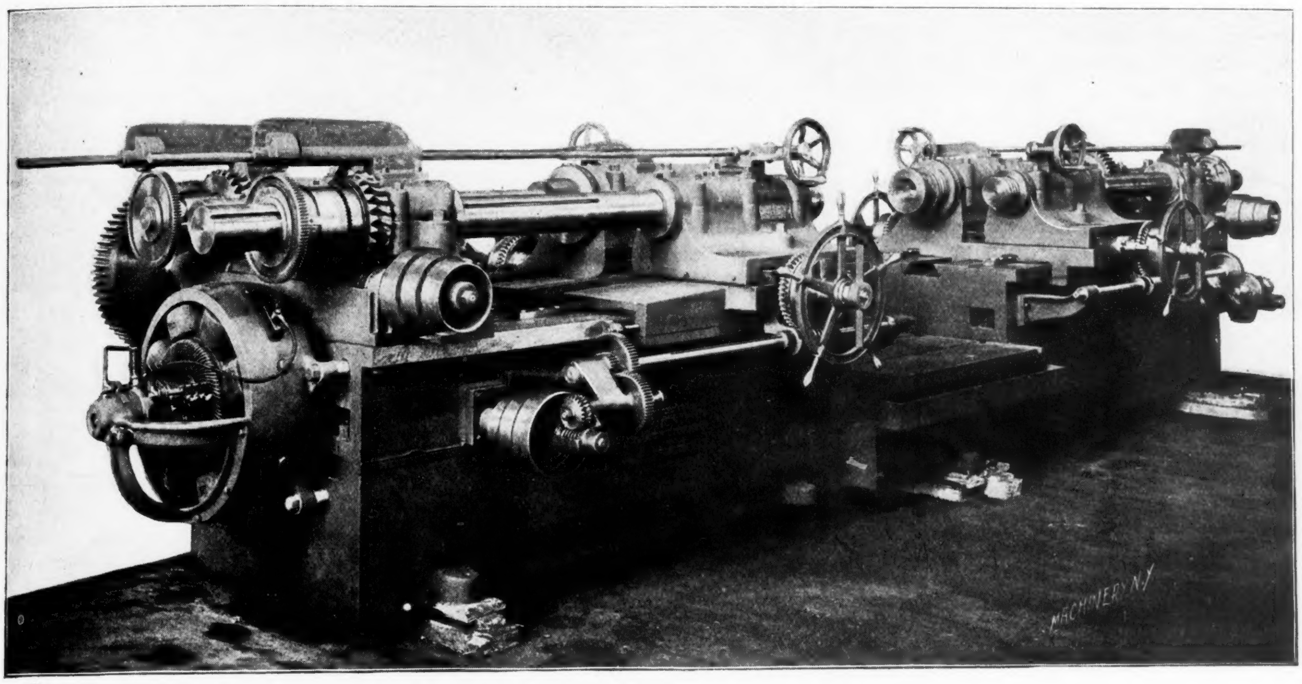
SHOP TERMS ILLUSTRATED.

CENTER PUNCH.

SPECIAL BORING MACHINE.

The machine shown in the accompanying engraving is an excellent example of the special tools being built for doing any kind of machine work when the quantity of the work to be done warrants the cost of the permanent investment required.

This tool is made for boring and facing the steel frames of the railway motors used on street cars, at one setting. The frames of these motors being of steel, a machine for boring and facing them rapidly must, necessarily, be of the most rigid construction and have a very powerful drive. The boring machine shown is one specially designed for this class of work by the Newton Machine Tool Works, and is said to fulfill all the requirements satisfactorily. The machine is driven by the independent motor seen attached to the end of the frame. The steel spindles, of which there are four, 6" in diameter, are driven by hardened triple thread worms engaged with phosphor bronze worm-wheels. The worms being made with right and left-hand threads, when both spindles at the same end of the machine are at work, the thrust is partially, if not wholly, balanced. The spindles are adjustable horizontally both longitudinally and laterally, so that motor frames of various sizes can be machined by shifting the position of the spindles to agree with the center distances required.



Newton Four-spindle Boring Machine for Railway Motor Frames.

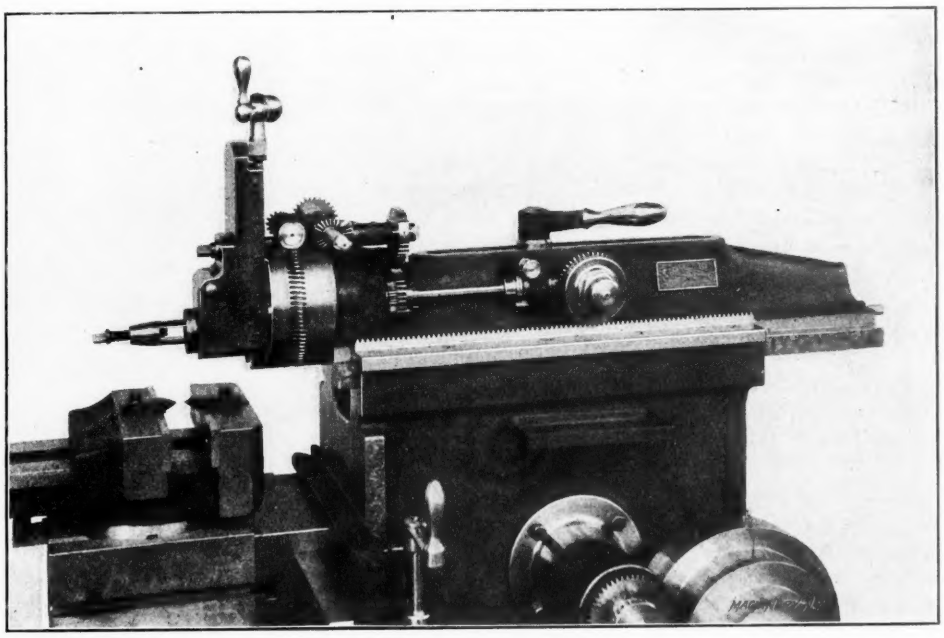
The field magnets of a railway motor frame are bored on this machine at the same time the hole for the car axle is bored. The facing and counterboring of the frame for the heads supporting the armature bearings is also done at the same setting, the boring tool being removed from the socket in the spindle and replaced with a special head for facing and counterboring. The motor frames are held in a special jig when being bored, the jig being so constructed that it automatically takes the correct position when lifted into the machine.

On the first machines of this type built by the Newton Company, it was necessary for the operator to be at the end of the machine to engage or disengage the feeding mechanism clutch. To obviate this unhandy feature, the machine shown is built with the shafts and hand-wheels seen over the main spindles, which enables the operator to engage or disengage the feed clutch without leaving the center of the machine. The longitudinal feed is controlled by the clutches in the pilot wheels at the side.

While this machine is designed for railway motor work, it is, however, as well adapted to some other classes of work in which it is necessary to bore parallel holes, such as duplex pumps, etc. The holes being bored in such a tool at one setting, time is saved and the parallelism of the holes assured.

SHAPER FEED MOTIONS.

The accompanying illustration shows the application of a down and an annular feed motion as applied by the Springfield Machine Tool Company, Springfield, Ohio, to one of their shapers. While it is evident that both of these feeds are not required at once, they are so arranged that each is at instant command. Motion to the feeds is transmitted through the agency of the gear which meshes with the rack, and this gear in connection with a pair of friction discs and a pair of bevel gears operates the shaft at the side of the ram.



Novel Shaper Feed Motion

The amount of reciprocating movement to regulate the feeds is determined by two stops, one fixed, and the other changeable by means of a small knurled knob, shown at the left of the gear

which engages the rack. This permits regulation of the feeds, while the machine is in motion, from zero to the greatest range.

The down feed is thrown in or out with a pawl on the lower gear, and the upper pawl takes care of the circular feed. Both of these pawls are reversible so that motion in either direction is obtainable. Should the shaper be used for any length of time, when automatic feeds are not desired, the gear which runs in the rack may be withdrawn so that no motion takes place. A feature of particular advantage possessed by this feed arrangement is that the stroke or the position of the ram may be changed to suit the requirements of the work, without altering the degree of feed, and without the necessity of making any adjustments whatever on the down or circular feeds.

It is obvious that the circular motion can be operated by hand, by placing the crank on the square end of the shaft which is at the side of the swivel head and very conveniently placed for the operator, who need not change his position to make any adjustment required.

The circular head is fitted to revolve on the end of the ram in carefully constructed bearings, so that no lost motion takes place when the circular feed is in use, and it can be securely clamped at any angle by two nuts, in the usual place, just as in any regular swivel head.

The amount of power required to drive the feeds is very slight, and the friction discs are fitted with an adjusting nut, so that any wear can be compensated for, and any required tension obtained.

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ITEMS OF MECHANICAL INTEREST.

NOTES OF PRACTICAL VALUE GATHERED FROM VARIOUS SOURCES.

A representative of Greenwood & Batley, Ltd., the English manufacturers of the De Laval steam turbine, states that the tests on a 300 horse-power turbine of this design show a steam consumption as low as 13.9 pounds of steam per brake horse-power per hour. If this result is a correct one, it is an unusually good performance, because an engine of this size of standard design would hardly run on a smaller consumption per indicated horse-power per hour and the consumption per brake horse-power would certainly be greater. The mechanical efficiency of an ordinary steam engine is seldom higher than 85 per cent.

It has probably been quite a mystery to many how the beautiful engraving on the cheap filled watch cases is performed. Many of these watches with good movements are sold for $12 to $15, with a warranty on the cases for fifteen years. It is obvious that the amount of gold contained in them is so small that it could not have a thickness sufficient to enable any engraving to be done which would remove the metal, as the baser metal beneath would necessarily be exposed. We are informed that the engraving on this class of watches is done by a diamond burnishing tool, which is a rounded diamond set in the end of a steel piece. The diamond is quite minute and when carried through the complicated pattern set by the engraving machine, it does not cut away the metal but grooves or presses the metal back as it proceeds. In this manner the watch case is wrought into the desired pattern and with a covering of gold that is of nearly uniform thickness.

In the brass foundry of the National Meter Works, Brooklyn, N. Y., an exhaust system is arranged for all the emery wheels used to grind the fins and sprues from the castings. Under ordinary conditions the brass dust is often wasted, as it is so much mixed with dirt and emery dust that it is practically valueless. In this plant, however, the exhaust is carried to a settling chamber where it is separated from the dirt. The result has been that as much as 900 pounds of clean brass grindings have been collected in two months. While these grindings are somewhat difficult to melt, they can be successfully handled by covering them with charcoal when placed in the crucible. The grindings and saw-dust collected from the band-saws used for sawing off the sprues make castings that are all right for the cheaper grades of brass fittings.

The exhausting apparatus thus not only preserves the health of the workmen, but pays a handsome interest on the investment in the value of the brass recovered.

"Domestic Engineering" states that a foreman of a gas company, while boring a hole under the pavement so as to get in a service pipe for gas without breaking up the pavement, ran his auger through a lead service pipe connected with a water main. Water was flying in all directions, and as the lead pipe had been laid some 30 years ago, and there was no record to show with what it was connected, the water could not be shut off. Finally the foreman broke open the pavement and jammed the end of the lead pipe, and stopped the water from flowing through it. The conundrum then was how to get the pipe repaired. A plumber was found who was equal to the occasion. He procured a lot of ice and some salt, and packed the mixture around the "live" end of the pipe, and soon froze the water solid in it. He then cut off the jammed end, inserted a piece of the broken length, made two joints, and removed the ice. The pipe soon thawed out and the water flowed through it all right. The spectators who saw how it was done voted the plumber a genius, but he claimed no extraordinary credit for his skill, stopping such leaks being only a part of his business.

At a recent meeting of the Central Water Works Association Mr. L. E. Hoit gave a paper upon the efficiency of water works pumping engines and stated that, considering the simple duplex pump, which is the most expensive of any to operate, to require an expenditure of $1.00 to $1.20 for pumping a certain quantity of water, it would be fair to estimate that the compound duplex pump would perform the same service at an expense of about eighty cents; the compound condensing duplex would call for an expenditure of about fifty cents; the compound condensing high duty, about seventeen cents; the triple expansion non-condensing, about thirty-five cents; the triple expansion condensing, twenty-five cents; and the triple expansion high duty engine, about fifteen cents.

If the efficiency of the various m chines just mentioned were to be expressed in foot pounds, the duty of each would be respectively 17 to 20 million for the duplex; 25 million for the compound; 40 million for the compound condensing; 118 million for the high duty compound; 57 million for the triple; 80 million for the triple condensing; and about 135 million for the high duty triple expansion. The duty given above for each engine varies, of course, with the different conditions; but it is near enough to enable one to understand the relative cost of operating each machine.

The "American Machinist" and the "Engineering Record" recently gave two kinks of value to draftsmen relative to cleaning tracings and restoring the glaze. A correspondent to the latter journal says:

Very few engineers or draftsmen seem to know that tracing cloth can be very quickly and easily cleaned, and pencil marks removed, by the use of benzine, which is applied with a cotton swab. It may be rubbed freely over the tracing without injury to lines drawn in ink, or even in water-color, but the pencil marks and dirt will quickly disappear. The benzine evaporates almost immediately, leaving the tracing unharmed. It must, however, be borne in mind that the surface has been softened, and must be rubbed down with talc, or some similar substance before drawing any more ink lines.

The "American Machinist" states that the chief draftsman of the Rushmore Dynamo Works in Jersey City has discovered that the glaze may be restored to tracing cloth after using the eraser by rubbing over the roughened surface with a piece of hard wax from an old phonograph cylinder. The surface thus produced is superior to that of the original glaze, as it is absolutely oil and water proof.

In the Rushmore works all pencil drawings that go into the shop are first rubbed over with this wax, and it has been found that while common pencil drawings are soon destroyed by dirt and grease, those treated with the wax return to the drawing room after the completion of special jobs without the slightest blemish.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

To encourage our readers to send more descriptions and photographs of good shop kinks and handy devices, we will give contributors the privilege of selecting from the appended list of desirable machinists' tools, according to the value of the different devices submitted.

To compete, it will be necessary to observe the following conditions:

1.—All descriptions shall be written on one side of the paper only.

2.—The necessary sketches to illustrate the device shall be made on separate sheets from the written matter.

3.—Tools shall be chosen from the following list, as no option in the selection of other tools can be given.

All contributions to this department will be graded, according to value, into four classes. Contributors will be informed by mail during the month following publication, from which class they may make their selections. Cash payment will be made in all cases, if preferred.

		List Price.
1.	Starrett's No. 9 combination square, 12-inch blade, with center head and bevel protractor	$4.00
	Sawyer's No. 100 surface gage with 12-inch and 18-inch spindles	3.50
	Slocomb's No. 17 outside micrometer caliper	3.50
2.	Sawyer's No. 39 combination square with 12-inch hardened blade	2.50
	Starrett's No. 56 tool maker's case-hardened surface gage, without auxiliary guides	2.50
	Slocomb's No. 12 internal micrometer caliper with depth gage attachment	2.50
	Starrett's No. 11 combination square, 12-inch blade, with center head	2.00
3	Slocomb's No. 11 internal micrometer caliper	1.75
	Starrett's No. 13 4-inch square, with two blades	1.65
	Starrett's No. 15 universal bevel	1.50
	Sawyer's No. 18 spring tempered rule, 12 inches long	1.25
4.	Starrett's No. 40 screw pitch gage	1.00
	Sawyer's No. 19 flexible rule, 9 inches long	.90
	Starrett's No. 79 outside spring caliper, 4 inches	.75
	Starrett's No. 73 inside spring caliper, 4 inches	.75
	Starrett's No. 83 spring dividers, 4 inches	.75

TOOL RELIEVING DEVICE.

The tool-relieving device shown in Figs. 1 and 2 is one that was recently seen in the shops of the Waltham Watch Tool Co., at Springfield, Mass. The device was being used for raising a planer tool from the T-slots which were being cut in a table having a narrow oil-retaining channel around the outside. The channel was so narrow that the tool could with difficulty be raised by hand from the T-slot before the beginning of the back stroke and the use of a strap or any other device to follow the tool was out of the question. It was therefore necessary to use a lifting mechanism that could be attached to the side of the

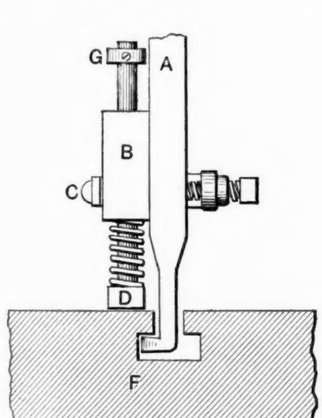

Fig. 1.

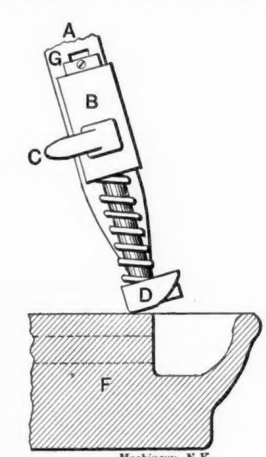

Fig. 2.

tool, so as to operate within the narrow space of the oil channel. As will be seen, the device mentioned is so made that it can be attached to the side of a planer, or shaper tool by an ordinary C clamp as shown in the accompanying cuts. The sliding shoe D is provided with a spindle working through the block B and with an adjustable collar at the top. A coil spring between the shoe and the block B, holds the shoe against the face of the table being planed. When the end of the T-slot is reached, the sliding shoe falls into the oil-channel and raises the planer tool above the table, when the motion is reversed, as illustrated by Fig. 2.

TO DO PRESS WORK IN A LATHE.

Mr. Frank Creiner, New York City, sends a scheme for using an ordinary lathe to do the work of a press (where there is none in the shop), in cutting off any number of short pieces of flat stock. The piece A in Fig 3 is called the punch and is made of tool steel with a tongue planed on its lower side to fit one of the slots in a face-plate. The punch may be secured to the face-plate by machine screws or by a horse-shoe clamp suitably placed. The die B is also made with a tongue on its lower side to fit the slot for the tool post in the cross-slide. To securely hold the die, it is best to drill and tap a hole in the slide and a clearance hole in the die for the filister head screw D, which

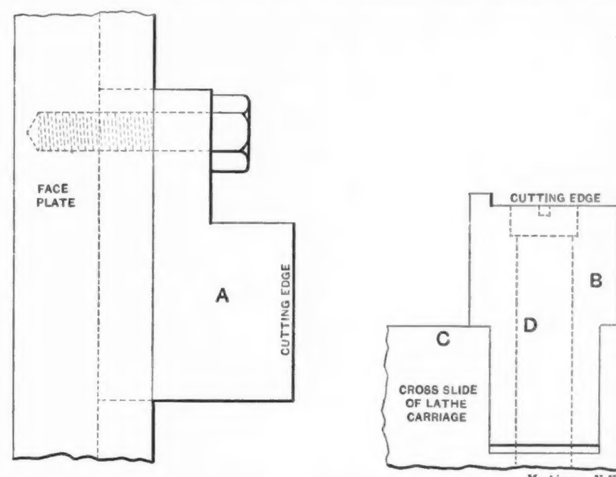

Fig. 3.

will hold it in place rigidly. The die B is made, preferably, with the shoulder indicated which acts as a guide for the stock being cut. When cutting the stock, always let the last slot preceding the die pass before shoving the end against the face-plate. The lathe should be speeded up and should be run with the back-gears in. Every time the face-plate turns around the trick is done.

SURFACE GAGE WITH TWO POINTERS.

Mr. Harry Ash, Chicago, Ill., says: I inclose two sketches of a surface gage which illustrate an original idea of my own, which, from personal experience, has been found to be a great saver of time and of milling cutters. While it can be used on the planer or shaper, I have always used it on a milling machine. By its use the operator can raise the table to take any desired chip without testing the cut two or three times and without danger of taking a cut that is liable to break the cutter. This tool is especially valuable on castings, as raising the table and allowing the cutter to revolve in the gritty surface while finding the lowest spot is very disastrous to the cutting edges.

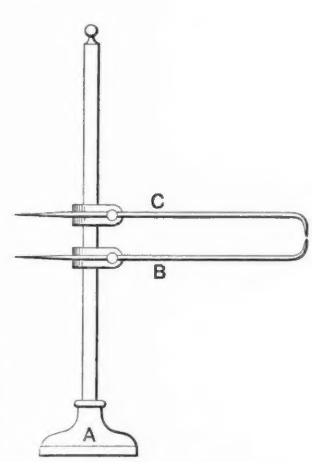

Fig. 4.

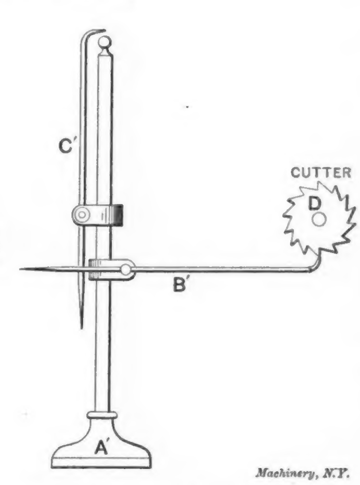

Fig. 5.

To use this surface gage, the pointer marked C in Fig. 4 is set to the lowest spot in the casting and then the pointer is set from it with perhaps 1-32" between the points for a cut sufficient to clean up the surface. Pointer C is then folded up as shown at C' in Fig. 5, and the table is raised until the pointer B will just touch the under side of the cutter as shown at B' in Fig. 5. In this way the table is quickly adjusted to a cut that will clean the casting or other piece being machined, and with no cutting or trying whatever.

FACING TOOL.

Wilfred J. Thompson, Ingersoll, Can., says that the facing tool shown in Fig. 6 is made by turning the shank A to fit the drilled hole, having an under surface to be faced, and that the shank is squared for about 1½" from the bottom. The lower end of the squared part is provided with a slot for the key C which is an easy fit from either side. The cutter B is made to cut left hand to obviate crossing the driving belt, and is provided with

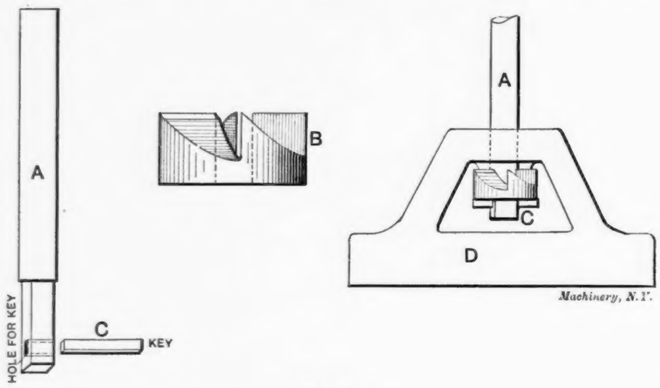

Fig. 6.

a square hole nicely fitted to the squared end of the shank A. The shank is held in a drill chuck when the castings are being faced off. To use the tool, the shank is slipped through the drilled hole and then the cutter is slipped on and held in position by the key C. The device is shown in place in the casting D. The advantage of the squared shank is that it allows of a much heavier cut being taken than is possible with the ordinary slotted shank having an inserted cutter. A much larger surface can thus be trued up, a feature that is often quite desirable.

CENTER INDICATOR.

The center indicator shown in Fig. 7 is an easily arranged makeshift for accurately chucking a piece true with a bored hole which is partially concealed by an overhanging flange or lip, as indicated by P. The wire pointer is drilled for the cross wire W which is inserted at right angles to the axis of the pointer. The cross wire W is lightly held between the point of the tool-post

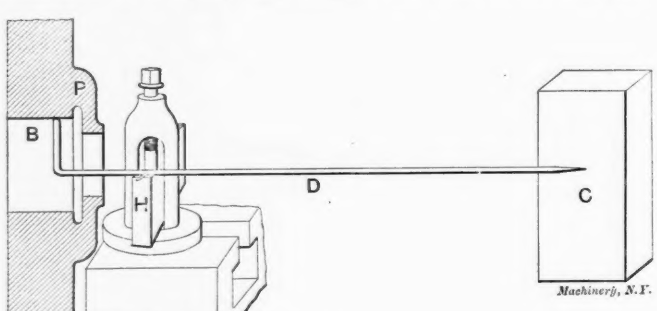

Fig. 7.

set-screw and a hardwood piece H. The bent end B of the pointer is held against the upper side of the hole, being overbalanced by the outer end, and any eccentricity of the hole is indicated and somewhat multiplied by the outer point. To prevent excessive vibration, the end of the pointer is allowed to slide along the side of the block C or an angle iron set on the lathe shears.

EXPANDING CENTERS FOR PIPES, COLUMNS, ETC.

A correspondent "R" sends a sketch, Fig. 8, and description of an expanding center for pipe, etc. He says that by reference to the accompanying sketch it will be found that piece A is bored and has six ½" square holes broached in it at equidistant points around the circumference, three at each end and equally spaced. The two pieces marked B B' are turned to a sliding fit in A, and 3 taper grooves are cut in each one to match the square holes in A. B is tapped to fit screw G, while B' is drilled out so as to slide freely along G. G is a 1" bolt with a good center reamed in the head end. Pin D is required to keep B' close up to the head of C, while E is required to keep B and B' from slipping clear through A. The two pins D and E are not absolutely necessary but contribute quite a good deal to the successful working of the center. F F F, etc., are ½" square cold rolled steel pins with case-hardened points, several sets of which are needed.

The center, as shown, is complete for a 4" pipe and admits of a ½" variation in size of pipe, viz.; from 3¾" to 4¼", the next set of pins would be made a little longer so as to suit from 4¼" to 4¾", and so on.

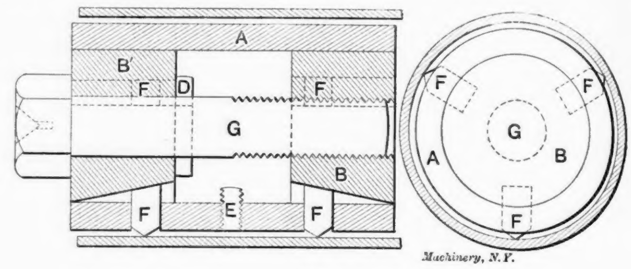

Fig. 8.

In using this center care must be taken to keep it in the position shown in sketch, that is, when putting in or taking out the pipe; the workman can then place one finger on each of the two lower pins so as to prevent them falling out, and the other four pins will, of course, stay in themselves.

The strong points of these centers are their accuracy, low price for making, and facility in operation, as both ends of the pipe can be easily centered in two minutes. Also on account of their length, they are much more likely to be in line with each other than the common "spider" or cone centers used.

A NEAT FACING RIG.

R. P. Perry, Hoboken, N. J., says that this facing rig for a boring bar was recently called to his attention while passing through a large shop devoted to the manufacture of plumber's specialties.

The principal features of this rig are its neatness and compactness. The tool-holder B is square and is fitted in a square hole passing through the boring bar A. The tool-holder is

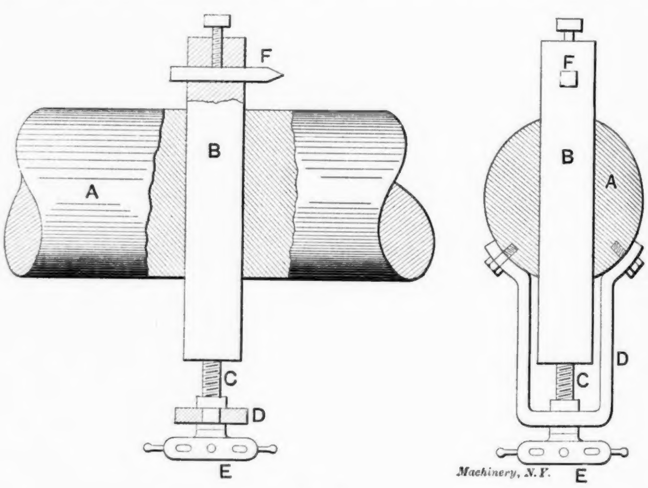

Fig. 9.

operated by the screw C and the star-wheel E which are held in place by the wrought iron loop D. The loop is held to the bar by the two tap bolts shown. As will be seen, the tool F can be drawn very close to the boring bar when facing a flange, and, in fact, a flange can be faced to its inner edge when the bar is almost as large as the hole through the piece. This is accomplished by grinding the tool so as to cut with the edge next to the bar and by also having the bar recessed so as to allow the tool to be drawn slightly below its surface.

* * *

A CORRECTION.

A correspondent calls attention to the fact that the formula used in question 40 of the February number should be written with the exponent 1.41 applying to the volumes instead of to the pressures, as there given. Subscribers who have the February number will kindly note this correction, since the formula is quite misleading as it was published.

THE EVOLUTION OF ARCHIMEDES.—1.

A TRUE BIOGRAPHY.

JUNIUS.

I call him Archimedes because that was not his name and because he had no ambition to move the earth with a lever.

He was a green, uncouth sort of a lad at first, brought up in a country village, 'steen miles from a railroad. He wore cowhide boots and a flannel shirt with a paper collar, in the winter, and in the summer went bare-foot and wore a cotton shirt with no collar at all. For all this, he had yearnings for wheels that turn and for tools that cut. He fitted up a work-bench from a big dry-goods box and stocked it with such tools as he could buy, beg or borrow. He even acquired in some way a nondescript sort of a turning lathe and jig-saw, which gave him cramps in his right leg, and where his turning-gauge invariably kept time with the churning of his foot. In school he preferred Geometry to Latin, and out of school he found even the buck-saw more attractive than the hoe.

Fig. 1.

An opportunity to work occasionally in a planing mill made him happy, in spite of blistered hands, and so developed his liking for machinery that Archimedes senior became convinced of the boy's aptitude for the shop rather than the college. Accordingly Archimedes had his hair cut bought a new trunk and a suit of store clothes; then one cool October morning bade adieu to his parents from the front seat of the stage and rode away over the hills.

We next find him entered as apprentice in the machine-shop of Bang & Ammer, Jobbers in Wood and Iron. To his eyes the dark, oily, grimy room was fairyland, every revolving shaft and plunging rod had a mysterious charm, and the men in blue jumpers and over-alls, who handled the cranks and pulled the levers, belonged to a higher order of beings. Even now the peculiar odor of iron chips mixed with oil has a fascination for his nostrils, superior to that of rose or carnation. Archimedes could hardly believe it possible that he was to be permitted to enter these sacred precincts and learn these mysteries, still less that he was to be paid ten cents an hour for doing it. Those who knew said that he must have a jumper and over-alls, too, and that they must be of "'hucker-bucker" (brown duck). Now this humble material, when washed, shrinks worse than the volume of the currency in a panic. Accordingly Archimedes bought his over-alls large, as they cost him no more, and when he first appeared on the scene, "over-alls" seemed to express it exactly. Archimedes was a cleanly lad, and as the shop was certainly dirty, he washed himself faithfully every day and the over-alls once a week. But Archimedes did not shrink, or at least only temporarily, and the over-alls certainly did. At the end of the second week he concluded that his suit just about fitted him; at the end of the third week he had doubts. I leave the remaining weeks to the imagination of the reader.

Fig. 2.

Fig. 3.

Fig. 4.

When Archimedes entered the shop on that first morning, he was introduced by Mr. Ammer, who was foreman as well as proprietor, to a tangled assemblage of belts, pulleys, gears and grease, called a "gagger." Now this machine was intended to cut bolts and tap nuts, but incidentally, by virtue of its concentrated smell of rancid oil, it could nauseate almost any one in a day of ten hours. Hence its name. "That which we call a rose, by any other name would smell as sweet." A healthy boy of eighteen, working ten or twelve hours a day, cannot be discouraged by any such little thing as a smell. So as Archimedes toiled on from day to day and from week to week, the "gagger" stimulated his already lusty appetite, until the man with whom he boarded began to have deep hollows under his eyes, and the landlady cut the bread still thinner and put more gristle in the hash.

Bang & Ammer had no time system worth mentioning and every man kept his own count, charging up as many hours as his conscience would allow and then throwing in one or two for luck. In rush times, when there was plenty to do, the men were allowed to work as early and as late as they chose. It was the duty of the first man in to build the fire in the shop stove, if it was winter, and to open the gate in the wheel-house which started the water-wheel in motion. Like most shops "Down East" it had cold water instead of hot steam for motive power and there was no boiler to clean, no ashes and clinkers to shovel out, no engine to oil and wipe. There is a gruesome tale of one man who came early and went into the wheel-house to open the gate. The next man who came found the machinery in motion and no one in sight, and went into the wheel-house likewise. The room looked like shambles. The first man in some way had caught his clothes in the rapidly whirling wheel-shaft and was dashed to death.

Fig. 5.

Archimedes needed the extra pennies as bad as any one, so he usually managed to be the first one in the morning, built the wood fire in the big sheet-iron stove and stood around in the warmth, while he buttoned his jumper and strapped up his over-alls. Sometimes he stood and chatted a few minutes with another early bird. He became possessed of a tin coal-oil lamp, with a very smutty chimney, and by this dim apology for a light he started up his bolt-cutter or his drill-press in the cold winter mornings. It was a difficult matter to squeeze in ten hours in these short days of winter, but by hurrying his dinner down in twenty minutes and running both ways he managed to get there.

In the summer time the days were longer and twelve hours or even thirteen were possible. Bang & Ammer finally concluded that some men were too good to themselves, and that a time-keeper would help check their benevolence. Archimedes was the individual selected for this position, and every morning about nine o'clock, armed with a time-list and a pencil, he hunted up each workman and asked him how many hours he had worked the day before. Even this system had holes in it that a cat might jump through, but after several men had confessed to ten or eleven hours on days when it was easy to prove that they had not been near the shop, there was an improvement in the shop conscience and a corresponding shrinkage in the pay-roll. But this is getting ahead of our story.

It was a proud moment in Archimedes' life when the foreman suggested to him that the overhead belt which drove the counter of the emery wheel was slack and needed taking up. He had often seen the older men do this and knew just how to proceed. He hauled the ladder down from its place over the bolt-cutter

and set it up against a floor timber near the belt. He went to a drawer under the bench on the north side of the shop, where the lace-leather and belt-punch were kept and carefully cut a lacing of the right width (he had cut leather whip-lashes from old boot-legs when at home). Fortunately the belt was an open one and there were no complicated problems as to which way to twist it. He cut an inch from its length, punched some new holes and re-laced it as he had seen the men do, straight loops on the inside and crossed loops on the outside, fastened the ends and finally managed to slip it on the pulleys, without losing his fingers or breaking his arm. It ran straight and true, quivering with its

Fig. 6.

tightness, and Archimedes triumphantly descended the ladder. But what is this new complication? As Archimedes tries to take the ladder down, it resists and acts as if alive. Looking aloft he sees a tangle of ladder rounds and belts, until there comes over him the sickening conviction that both plies of the belt are running through the ladder. There are but two ways out of it, either to unlace the belt or dissect the ladder, and Archimedes sorrowfully chooses the former, while his shop-mates grin loudly.

At Bang & Ammer's shop they did everything that came to them to do, from mending mowing-machines to re-building a locomotive. The establishment contained wood and pattern shops, foundry and blacksmith shop, as well as the machine shop already mentioned, and our apprentice had more or less to do with all of them. On "melting" days, which came once or twice a week, he had to go into the foundry and "skim" the ladles as

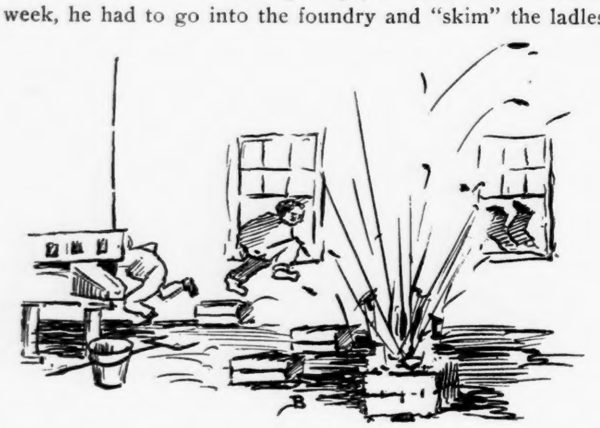

Fig. 7.

the foundrymen poured the molten iron into the moulds. He learned to have a wholesome respect for this same iron and not to wear cotton over-alls or low shoes in its vicinity. Occasionally, a poorly vented cope would rise and let out a cupful of the red syrup, and Archimedes will never forget the day that a ladleful of hot iron struck a rusty chill in the mould and rebounded in a bewildering explosion, throwing drops and spatters of liquid fire to every nook and cranny of the building. The boy can never remember just where he went and what he did, but when he got his wind and his eye-sight, there was a sprawling figure outside each open window and the air was nearly as full of hot language as a moment before it had been of hot iron.

This foundry adulterated its pig-iron with scrap, which it purchased from the neighboring farmers and store-keepers—old stoves and kettles, with now and then a plow-point. These last made hard places in the castings which broke the drills and dulled the lathe-tools. Sometimes a load of scrap-iron came on the cars and Archimedes, being only an apprentice, was detailed to go with the teamster and help load and unload the cart. Scrap iron has a great many fine points about it, and when you throw it from a cart to a cupola stage, you find out most of them. Hands cracked and blistered, covered with ashes and soot, these were the disagreeable features. Once in a while came a whole, second-hand cooking range to be broken up. Then how Archimedes enjoyed swinging a ten-pound sledge up over his shoulder, striking a knockdown blow exactly in the center of the top of that range, hearing the crash and seeing the splinters fly. It was worth the price of admission and somehow relieved his feelings. What old relic of barbarism is it that makes us like to smash things?

On other days Archimedes had to go to the blacksmith shop and help old Carl, the smith. Carl was a good-natured man and something of a humorist in his way. Of course the boy was rather awkward at first and the sledge had a habit of going anywhere but in the right place. It would perhaps turn in its descent and strike the chisel of the fuller a glancing blow which would send hot shivers into Carl's fingers and perhaps send the chisel itself whirling to the ground. Carl would swear under his breath and then grin, and Archimedes would get red in the face, but they came to be great friends. Gradually the boy learned confidence, so that the sight of the head of a chisel or the flying hammer of the smith did not make him nervous, and he could get there with his sledge at the right time and place. He had to go to Carl to get his lathe tools and his drills sharpened and tempered. They used the old-fashioned flat drills at Bang &

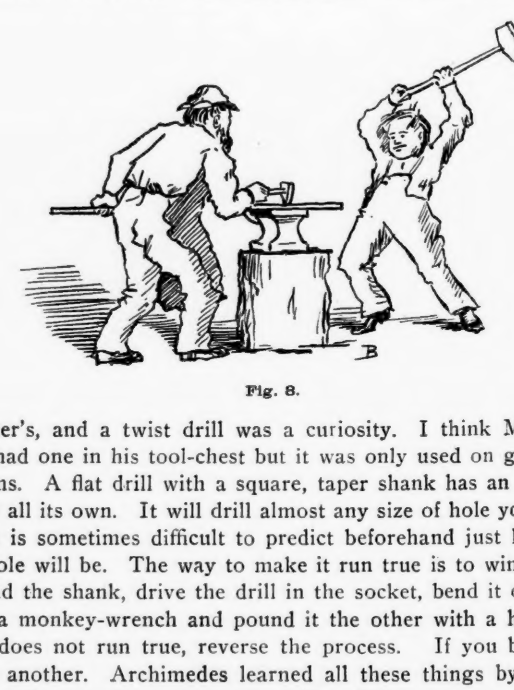

Fig. 8.

Ammer's, and a twist drill was a curiosity. I think Mr. Ammer had one in his tool-chest but it was only used on great occasions. A flat drill with a square, taper shank has an individuality all its own. It will drill almost any size of hole you want, but it is sometimes difficult to predict beforehand just how big the hole will be. The way to make it run true is to wind paper around the shank, drive the drill in the socket, bend it one way with a monkey-wrench and pound it the other with a hammer. If it does not run true, reverse the process. If you break it, make another. Archimedes learned all these things by experience and got to be an expert in drills. If he once succeeded in making a drill run true and cut the right size, he marked it to show which way it went in the socket and then hid it where he only could find it. This was selfish but justifiable.

Archimedes gradually began to experiment in blacksmithing on his own hook, for Carl was sometimes too busy to sharpen tools. He learned to build a fire in the spare forge and to tell when it had coked enough; to heat the drill in the right place and just enough; when to begin hammering and when to stop; to heat again and dip the point carefully in the water tub for an instant; to scour the flat surface hastily on a sanded board and then watch the colors stealing down from the hot shank, first straw-color, then orange, red and finally purple, until another quick plunge in the water stopped the procession. This is one of the things that few apprentices learn now, in these days of twist drills and grinding machines.

On one occasion Archimedes covered himself with disgrace

and came near being banished from the blacksmith shop. Old Carl had a trip-hammer under which he forged most of the heavy work. One day, when the boy was helping Carl, the old smith asked him to oil up the hammer.

So Archimedes got his oil-can from the machine shop and proceeded to oil everything about the machine that looked as if it needed oiling, and finally put on a finishing touch by oiling the catch-up liberally. When Carl started the hammer on his next heat, it went frantically and seemed to have no idea of stopping. It pounded the iron into a shapeless mass, it pounded the bare dies, and it would be pounding yet if Carl had not slipped the belt.

It took the old smith a half hour of hard work with emery cloth to get the greasy surface off that catch-up, and it was another half hour before Archimedes dared to show his head.

* * *

TESTING THE STRENGTH OF MATERIALS.—3.

TORSION TESTS.

EDWARD F. MILLER.

Until within recent years, comparatively little has been done in this class of testing. Although a general idea of metal can be obtained from tests made on tension specimens, facts are often brought out by torsion tests of which tension tests give no evidence. At the Engineering Laboratories of the Massachusetts Institute of Technology, three machines are used for this class of testing. Two of these machines, one of 150,000 inch pounds capacity and one of 6,000 inch pounds capacity, were designed at the Institute, the third is an old pattern Riehle machine of 60,000 inch pounds capacity.

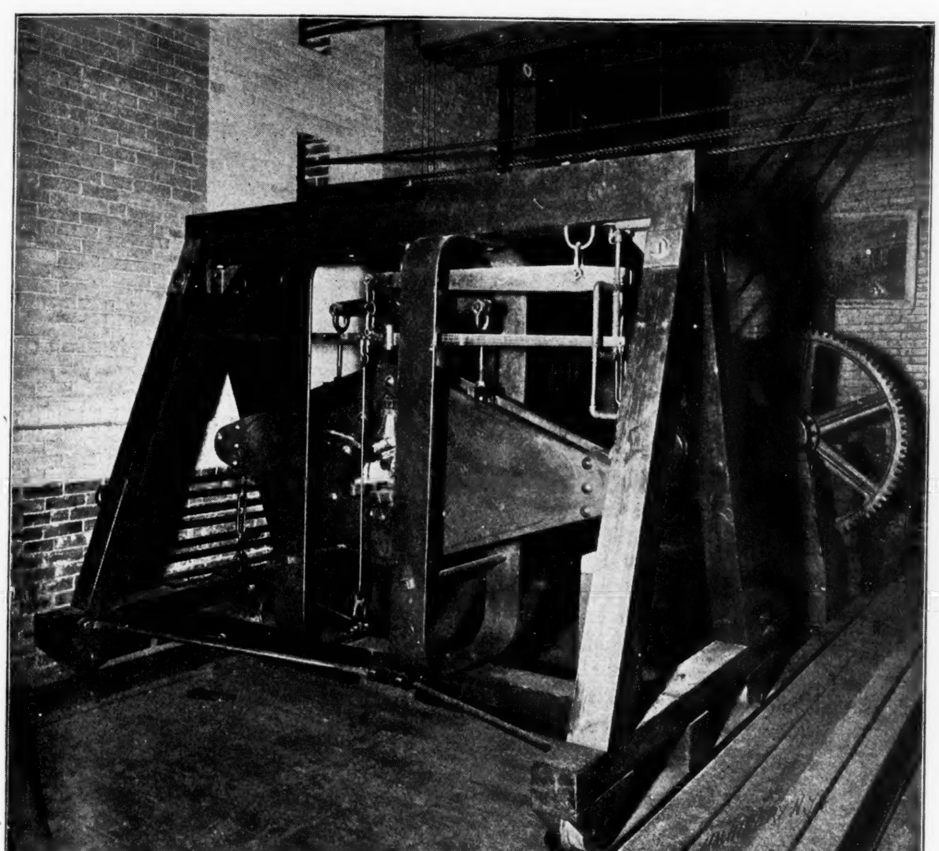

Fig. 2. Torsion Testing Machine, Weighing End.

Figs. 1 and 2 show the large machine of 150,000 inch pounds capacity. The specimens commonly tested in this machine are from $1\frac{1}{2}''$ to $2\frac{1}{2}''$ in diameter and of lengths varying from 3 to 12 feet. Fig. 1 represents the power end of the machine. It is driven by a 4″ belt running from a countershaft overhead. The gear B is keyed to a $4\frac{1}{2}''$ diameter steel shaft, which turns once in about fifteen minutes. The holder is a massive piece of cast iron, re-inforced by two bands of wrought iron 3″ wide and 1″ thick, shrunk on the outside. The grips are made of cast iron, faced with cast steel which is fluted on the outer surface. As will be seen by reference to the cut, these grips are cams which tend to bite the specimens harder and harder as the twisting head turns to the right. A short piece of a broken specimen of 2″ diameter steel is shown in the grips. These grips do not require a shouldered specimen. Steel bars $1\frac{1}{2}''$ in diameter containing 1.10 per cent. carbon have been gripped without the least difficulty. A hand wheel is attached to the driving shaft A so that any desired twisting moment may be held on the specimen. This is also used in adjusting the load accurately when the angle of twist of the specimen is being noted.

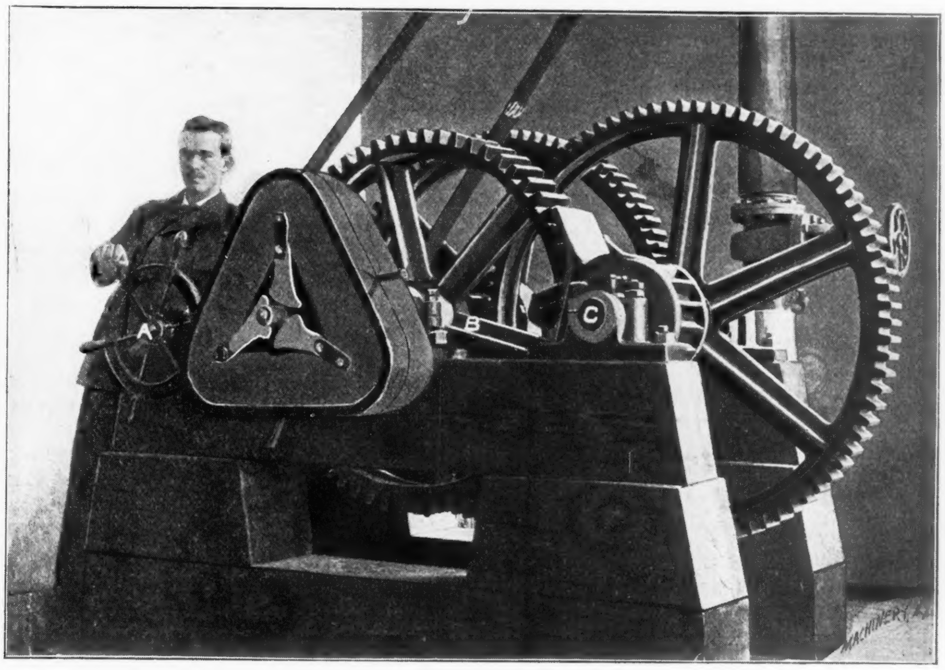

Fig. 1. Torsion Testing Machine, Power End.

The weighing end is held in a movable carriage which runs on I beam tracks. A casting, with grips similar to those described above, is attached to a hollow frame made of boiler plate, which is hung from the carriage by an equal arm lever and links, all turning on hardened steel V-shaped knife edges. From a knife edge at each end of this frame a link runs to a lever, one lever being near the top of the carriage and the other near the bottom. The free ends of these levers connect with the weighing beam shown running across the carriage. As the power end holder turns towards the right, the twisting moment, transmitted through the specimen, will tend to rotate the frame so as to cause the right-hand end to go down and the left-hand end to

go up. This causes the free end of the weighing beam to lift and the poise weight must be moved to the right to bring this lever level again.

It may be of interest to describe briefly the method by which the angle of twist for a certain twisting moment and the elastic limit in torsion are obtained.

At either end of the specimen, within about 6″ of the grips, a casting carrying a telescope with cross hairs (such as is used on levels) is attached to the specimen by sharp pointed screws. These telescopes are focused on vertical scales fastened to the wall of the room some 40 feet distant. The reading of each scale corresponding with the center of the machine and the distance from the center of the machine to the scales are determined once for all time. The distance of the center of the telescope above the center of the specimen is measured for each test. See Fig. 3.

$$\frac{cb - a}{Y} = \tan A \qquad \frac{c'b - a}{Y} = \tan A'$$

$$\frac{fe - a}{Y} = \tan B \qquad \frac{f'e - a}{Y} = \tan B'$$

$(A - A') - (B - B') =$ angle of twist in distance X.

In this figure T,W is the shaft, T being the twisting end.

Following is a log of a test with the calculation of the results

TORSION TEST.

Specimen. Refined Iron. Date, November 13.

Twisting Moment.	Scale Readings. Power End. 1		Scale Readings. Scale End. 1		Corrected Mean. Power End.	Corrected Mean. Scale End.	Angles Corresponding. Power End. ° ′ ″	Angles Corresponding. Scale End. ° ′ ″	Differences. Power End. ° ′ ″	Differences. Scale End. ° ′ ″	Angle of Twist. ° ′ ″	Remarks.
	1	2	1	2								
1	2	3	4	5	6	7	8	9	10	11	12	
1,800	93.23	93.23	89.91	89.92	84.08	81.86	9, 32, 40	9, 17, 50	.. .. ..	.. .. ..	.. .. ..	Specimen fractured 13″ from power end jaw.
3,600	84.52	84.54	84.62	84.61	75.38	76.56	8, 34, 20	8, 42, 20	0, 58, 20	0, 35, 30	0, 22, 50	
5,400	73.62	73.63	77.22	77.20	64.47	69.16	7, 20, 50	7, 52, 30	0, 73, 30	0, 49, 50	0, 23, 40	
7,200	68.83	63 84	70.90	70.90	54.68	62.85	6, 14, 30	7, 9, 50	0, 66, 20	0, 42, 40	0, 23, 40	
9,000	55.35	55.34	65.93	65.92	46.19	57.87	5, 16, 40	6, 36, 10	0. 57, 50	0, 33, 40	0, 24, 10	
10,800	47.10	47.11	61.12	61.12	37.95	53.07	4, 20, 30	6, 3, 30	0, 56, 10	0, 32, 40	0, 23, 30	
12,600	38.71	38.72	56.21	56.22	29.56	48.16	3, 23, 0	5, 30, 10	0, 57, 30	0, 33, 20	0, 24, 10	
12,600	91.86	91.86	89.40	89.41	82.71	81.35	9, 23, 30	9, 14, 30	.. .. ..	.. .. ..	.. .. ..	
14,400	83.70	83.72	84.87	84.88	74.56	76.82	8, 28, 50	8, 44, 10	0, 54, 40	0, 30, 20	0, 24, 20	
16,200	74.70	74 70	80.09	80.07	65.55	72.03	7, 28, 10	8, 11, 50	1, 0, 40	0, 32, 20	0, 28, 20	
18,000	64.32	64.33	75.12	75.14	55.17	67.08	6, 17, 50	7, 38, 30	1, 10, 20	0, 33, 20	0, 37, 0	
19,800	46.67	46.65	68.39	68.41	37.51	60.35	4, 17, 20	6, 53, 0	2, 0, 30	0, 45, 30	1, 15, 0	

Distance from center of test piece to scale	500.0″
Reading of level of center of test piece on scale	power end, 3.90″; scale end, 2.80″
Height of center of telescope above center of test piece	5.25″
Length of specimen between jaws	61.00″
Dimension of cross section	1.75 in. dia.
Length of specimen between telescopes	40.00″
Elastic limit in torsion	14,400 in. lbs.
Maximum twisting moment	53,360 in. lbs.
Number of turns of specimen between jaws at fracture	6.1
Outside fibre stress at elastic limit	13,700 lbs. per sq. in.
Apparent outside fibre stress as calculated from maximum twisting moment	50,700 lbs. per sq. in.
Angle of twist between 1,800 in. lbs. and 10,800 in. lbs	1° 57′ 10″
Shearing modulus of elasticity between 1,800 in. lbs. and 10,800 in. lbs	11,470,000
Average number of turns of specimen per foot at fracture	1.20

Columns 2 and 3 and 4 and 5 are readings as taken directly from the scales. Column 6 is obtained by subtracting 3.90 + 5.25 from the mean of columns 2 and 3, and column 7 by subtracting 2.80 + 5.25 from the mean of columns 4 and 5. Column 8 is the angle whose tangent is $\frac{84.08}{500}$ etc.; column 9 is computed in the same way. Columns 10 and 11 are the differences of successive readings in columns 8 and 9. The difference between columns 10 and 11 gives the angle of twist.

The angle of twist increases regularly by about 24 minutes for each successive 1800 inch pounds twisting moment till a load of 14,400 inch pounds is reached. At this load the rate changes. This we call the elastic limit in torsion. The outside fiber stress at this load is calculated from the formula:

$M = \frac{fI}{r}$ where M is the twisting moment in inch pounds

I the polar movement of inertia $= \frac{\pi r^4}{2} = \frac{\pi d^4}{32}$

r = radius of the specimen in inches

f = the required stress

$$f = \frac{2M}{\pi r^3} = \frac{2 \times 14{,}400}{3.1416\left(\frac{1.75}{2}\right)^3} = 13{,}700 \text{ pounds per square inch}$$

The apparent outside fiber stress as calculated from the maximum twisting moment is:

$$\frac{2 \times 53{,}360}{3.1416\left(\frac{1.75}{2}\right)^3} = 50{,}700 \text{ pounds per square inch.}$$

The shearing modulus of elasticity is calculated by the formula:

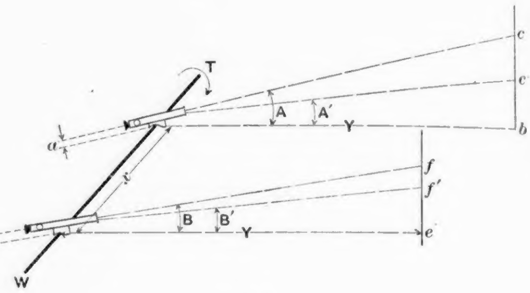

Fig. 3.

$$\text{Shearing modulus} = \frac{MX}{Ii}$$

where X is the distance between telescopes, as shown in the sketch. Here X = 40″. I is the polar moment of inertia equal in this case to .9208, i is the circular measure of an angle of twist produced by a certain twisting moment M. By increasing the twisting moment from 1800 to 10800 or by 900 inch pounds the angle of twist increased 1° — 57′ — 10″ or 1.9527°.

The circular measure of an angle of one degree is

$$\frac{3.1416}{180}$$

the circular measure of this angle is therefore

$$\frac{3.1416 \times 1.9527}{180} = 0.0341$$

Substituting numerical values we get:

$$\frac{9000 \times 40}{.9208 \times .0341} = 11{,}470{,}000$$

The shearing modulus of elasticity falls somewhere between 11,000,000 and 12,000,000, having its value equal to about 2-5 of the tensile modulus.

IMPACT TESTS.

A knowledge of the effects produced on a metal when subjected to a suddenly applied heavy blow or to a series of light blows is much needed. Car axles, crank pins, pump rods, etc., are all subjected to shocks, and many railroad shops have improvised impact testing machines for testing car axles. These machines resemble a small pile driver. Largely on account of the yielding of the supports on which the car axles rest, results from such tests, although of value in comparing metals, are not of much scientific value.

An impact testing machine has recently been added to the U. S. Government testing laboratory at Watertown, Mass., and was designed to assist in the scientific study of metals under different conditions of loading. A knowledge of the effects of repeated shocks on the strength and elasticity of a metal is of especial value in the design of guns, carriages, frames, etc.

REPEATED STRESS.

A good illustration of a repeated stress is furnished by a length of shafting when running with one or more of its bearings out of line. When a shaft is drawn out of line, either by a belt pull or by the weight of a heavy pulley, stresses similar to those in a beam are set up in the shaft. The fibers in that part of the shaft on the convex side of the curve are in tension and those on the concave side are in compression. At every turn of the shaft these stresses change from tension to compression and

from compression to tension. There is also an additional fiber stress due to whatever twisting moment may be carried through the shaft. The loading of the tension and of the compression members of a steel bridge varies as the load on the bridge changes. This gives another example of a repeated stress. The variation in the steam pressure in a steam boiler subjects the steel shell to similar conditions. In fact, the cases where this sort of action occurs are too numerous to mention.

Some investigations to note the effect of a repeated stress of a certain range on the life of a specimen have been made. For at least thirteen years some work of this nature has been carried on at the Massachusetts Institute of Technology, but, as a single test often consumes months of time, data does not accumulate rapidly. A paper by Prof. Jerome Sondericker of Massachusetts Institute of Technology, read before the Boston Society of Arts and printed in The Technology Quarterly, Vol. XII., No. 1, gives a summary of a number of his tests on repeated bending. Some results of tests of shafts subjected to combined twisting and bending were presented, by Prof. Gaetano Lanza, in a paper read before the A. S. M. E. and printed in Vol. VIII. of the Society's transactions.

* * *

HISTORICAL ANECDOTES.

In the November, 1899, number of this journal, we gave an abstract of Dr. Coleman Sellers' address at the time of the 75th anniversary of the Franklin Institute. This address contained numerous anecdotes concerning the early history of the machine industry and as it has recently appeared in full in the January number of the Journal of the Franklin Institute, we quote two of them that may be of interest, relative to the development of modern methods of planing and boring. Mr. Sellers said:

"The planing machine is an invention well within my own experience. In the beginning it had the platen, upon which the work is fixed, dragged backwards and forwards by a chain. The first planer that William Sellers & Co. purchased and put into use was one of this chain pattern, and one was introduced in my father's shops when he undertook to build a locomotive in 1834. At the time of the Vienna Exposition, where machine tools from Philadelphia were exhibited, the engineers sent by the British Government to Vienna to note the progress that was being made noticed the broad feed cut on all the planing machines, lathes and tools that came from all parts of America, and remarked upon it as 'producing good effect,' as 'looking well,' etc., as if it were for appearance only, not knowing that it was a principle that had been established in America, thoroughly understood not only by the managers of the works, but by workmen all over this country, and universally adopted as necessary to good work.

"When the early locomotives were built, for example, in the Niles Works, in 1856, the boring of the cylinders was done on a 36-inch lathe with a horizontal boring bar, and without any knowledge as to the theory of boring in order to produce the best results. It always took two days to bore the cylinder of a locomotive of the size in use at that time, and I think the largest cylinders were not over 15 inches in diameter. In Philadelphia, when Balwin's had advanced to a very large establishment, they still bored the locomotive cylinders in the same way. It was not until shortly before the Centennial Exhibition of 1876 that attention was turned towards the utilization of a theory that had obtained in limited practice some years before as to the improvement in boring metals, the idea being that the quickest and best work can be done in boring by making the roughing cut with a fine feed, removing as much metal as possible by depth of cut, and making the finishing cut with a very broad feed but light cut that would let the cutter pass through the hole to be bored as quickly as possible so as not to wear the cutting edge in passage. That principle was first introduced when Mr. Asa Whitney, of this city, discovered that chilled cast-iron car wheels could be made to compete with the best wrought-iron ones and do a greater mileage. The problem of boring chilled wheels was solved by taking advantage of the fine roughing cut and coarse finishing feed. Mr. Whitney desired to have wheels made interchangeable in their fit on the standard axles, so that when a wheel was fitted on an axle at a workshop in Philadelphia, another wheel could be furnished to fit that same axle at any future time and just as well as the first one."

"When the late Mr. Hudson had charge of the Rogers Locomotive Works he applied to the firm of William Sellers & Co., to have a special locomotive cylinder boring machine designed and built, saying that he had seen a boring machine designed by Mr. Grant, of the Grant Locomotive Works, capable of boring a 19-inch cylinder in nine hours. The matter was referred to me, and when I came to calculate the theoretical time required for boring a cylinder of the size named, on the supposition that the speed of 16 feet per minute might be used in making the cuts, with a fine feed and a deep cut for the roughing cut, and a shallow cut and a much wider feed for the finishing cut, I found that the estimated time amounted in all to only three hours, and named three and a half hours as not only possible, but what might be guaranteed as the productive output of such a machine. An order was given for this machine, it being understood that it was not only to bore the cylinders, but to counterbore the ends for the clearance of the piston, to cut off the sinking head and face up the flanges at each end of the cylinder. When completed, the first test was made with a 19-inch cylinder of hard close metal. This was bored in three hours and twenty minutes, exclusive of the time of setting the cylinder, which was not much on account of the peculiar arrangement of the machine, and the facility with which the cylinder could be put in place for boring. In this case the cylinder stood still, while the boring bar travelled lengthwise, carrying the cutter head with it, and upon the two face plates of the driving heads of the machine were arranged automatic slide rests that faced off the flanges."

* * *

A. S. M. E. ABROAD.

The plan that was talked of last winter of chartering a special steamer for the use of the members of the American Society of Mechanical Engineers who are to go to the Paris Exposition, has failed because of the inability of many of the members to state at so early a date just when they expected to be able to sail and even whether they would be able to attend at all. Circulars have, therefore, been sent out recently to the different members, asking when they expect to leave for the Exposition, if at all, and it is hoped that a considerable number will be able to congregate at London on or about July 5, on which date the Institution of Civil Engineers of Great Britain holds a reception, to which American Engineers are invited as guests. During the days that precede and follow—perhaps between July 2 and 9—the American Engineers are to be the recipients of courtesies from the English hosts, in the way of visits and excursions, which will be arranged for, and it is not unlikely that on the Sunday, July 8, there will be services of special interest either at Westminster or elsewhere, which the engineers would enjoy the opportunity to attend. Probably on the Monday or Tuesday following, July 9 or 10, the party will leave London by rail, in special trains, en route for Paris.

For those who may find it necessary to sail earlier, the Institution of Mechanical Engineers of Great Britain arranges to hold its London Meeting during the second week of June, which, it will be observed, is some weeks earlier than the date fixed for the other Society. The Mechanical Engineers of Great Britain invite the American Engineers to take part in their meeting and excursions, receptions, etc., and the date of the gatherings is sufficiently far removed to prevent conflict on the one hand, while leaving a space between the two meetings for the general opportunities of an English visit for those who may be able to spend time enough in London to avail themselves of both opportunities.

It is also probable that after the trip to Paris, arrangements will be made for the further entertainment of American Engineers by important bodies in Berlin. It is premature as yet to give dates as to the purposes of the engineering societies in either Paris or in Berlin.

* * *

It is estimated that one square foot of uncovered steam pipe will radiate 10 thermal units per minute, with steam at 100 pounds pressure. This is equivalent to the condensation of about seven pounds of steam at this pressure per square foot of pipe in a day of 10 hours.

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APRIL, 1900.

CIRCULATION STATEMENT.

The regular edition of MACHINERY for April is 21,500 copies. AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. Except on the special quarterly numbers, no papers are sent free other than to advertisers, exchanges and circulation agents.

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

THE IRON AGE, about	7,000
THE AMERICAN MACHINIST, about	12,000
MACHINERY	21,500

It can be stated as a general principle that whatever reduces the time and cost of fitting the parts of a machine together and erecting the same, is worth considering from the standpoint of economical production. One of the large users of gear wheels for heavy and rough work formerly employed gears with cast teeth, because, for the class of work turned out, they gave just as good results, and were fully as strong as wheels with cut teeth. Now, however, all the gear wheels made by this firm have cut teeth, and the reason for making the change was purely to save the excessive cost of fitting and erecting incident to the cast teeth. While a good mechanic and a helper had been known to take three days to fit two gears, with their shafts and their bearings, the same work where cut gears were employed scarcely required more than the same number of hours. Moreover, it is a question whether the cost of the cut gears is after all much greater than of the cast ones. The gears are cut by automatic machinery, improved grinding machines reduce the cost of keeping the cutters in shape and the wheel rims, which would not be finished if the teeth were cast, are turned and faced in this instance simultaneously with the chucking. The question of the expense of the cut gears, therefore, sifts down practically to a consideration of the interest on the cost of the machines used in making them.

LABORATORY WORK.

Prof. Breckenridge, of the University of Illinois, recently addressed the St. Louis Railway Club upon the subject of Technical education and gave the following reasons for the value of laboratory practice to the student of engineering:

(a) It teaches him to locate wastes (of material, of fuel, of power).
(b) It teaches systematic methods of investigation.
(c) It exercises his ability to make a clear written statement of the results obtained.
(d) It familiarizes him with the various types of commercial appliances used in practice.
(e) It gives him confidence in his own ability to do things.
(f) It fixes in his mind the useful constants, methods and records of engineering practice.

All will agree, we think, that these are good and sufficient reasons why laboratory practice should form a part of the instruction in every well-appointed course of instruction in mechanical engineering. It may justly be asked, however, whether the amount of time devoted to this branch of instruction and the degree of importance attached to it are not sometimes overestimated.

There can be no doubt that the laboratory idea is very popular, not only with the professors themselves and their students, but with practical men outside who are engaged in commercial work. In the early days of technical education there were no laboratories at all in any department. Chemistry, even, was taught from the text-book instead of by actual experience with chemical reactions in the laboratory. Then came chemical and physical laboratories and these were so successful that engineering, applied mechanics, metallurgical and other laboratories, devoted to the various engineering professions, followed as a natural sequence. They have all been successful, and have improved the different engineering courses very greatly, but in spite of their success it does not follow that too much laboratory is a good thing. A distinction should be drawn between the objects of the chemical and physical laboratories and, for example, the laboratory of mechanical engineering. The chemist spends his life, so to speak, in his laboratory, and so does the physicist, but the amount of time devoted to testing materials and appliances by the mechanical engineer is comparatively small. In fact, it is safe to say that nine out of ten of the graduates of technical schools never have any testing to do at all and of those that do, probably not one in ten has to do more than to conduct engine and boiler trials, or to make simple commercial tests that require but little special training.

It seems, therefore, to be an open question whether there is not danger of carrying instruction in laboratory practice to an extreme. Every student should be drilled thoroughly in engine and boiler testing and in making tests of the apparatus used and of the coal and gases, such as have to be made in any expert test of a power plant. He should also be grounded in the general principles of some few other tests and it might assist him in his future work if complete notes were furnished him giving directions for conducting a wide variety of other tests. Beyond this, however, would it not be better to make extended laboratory work an option, to be taken or not as elected by the student? Take, for example, the case of a student who expects to enter into manufacturing, and whose chief work will be in connection with the design of machinery and its construction in the shop. More extended courses in machine design and shop management than are ordinarily given would benefit him directly and to a greater extent than laboratory work. Many of the colleges offer options to the students and give them a wide choice in their courses of study; but as far as we know an equal amount of laboratory work is required of each and the amount of time taken for this is generally rather extensive. If this time were reduced for the regular courses and devoted to other subjects and then an option of more laboratory work offered, we think the average student would be better suited. There is too much laboratory work done under the guise of "practical work" when, as a matter of fact, it is not practical work at all in the sense of being in the line of work that is to be done by the student after graduation.

* * *

Our well-known contributor, Prof. W. H. Van Dervoort, is now in Paris on a brief business trip, and until his return, his series upon machine tools, that has been running through the last few numbers of the paper, will have to be interrupted.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

43.—H. B.: A friend and I have had an argument with regard to a gear problem, which we would like to submit to you for settlement. The question is this: Suppose we take two gear wheels, each having 24 teeth, and allow one wheel to remain stationary while the other is rotated about it, the teeth being in contact all the time. Will the rotating gear have made a revolution about its own axis when it has turned half way around the circumference of the stationary gear?

A.—In the accompanying sketches, let us suppose B to be the stationary gear, C the one that turns around it and A the arm connecting the two gears, in order to keep them in contact. We will first assume that both gears and the arm are locked fast together and that they are all turned as one piece about the axis of B one-half turn, to the position shown in Fig. 2. Each part,

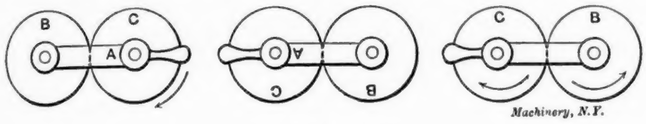


Fig. 1. Fig. 2. Fig. 3.

A, B, C, will then have made ½ turn about the axis of B. Now, we have done just what we wished to do with the arm A, namely, turned it half way round, but have at the same time turned B, which was to have remained stationary. Hence, we will now hold the arm stationary and turn B back to its original position, as shown in Fig. 3. This operation will cause C to make another half turn, bringing it to its original position, except that it is at the left of B instead of at the right, as in Fig. 1. We have thus completed the desired operation, but have done it by two separate movements for the sake of analysis. It will be seen that in the process C has made one complete turn, but one-half of this turn was made about the axis of B and the other half about its own axis. Hence the answer to your question is that while the gear makes one complete turn in passing half way around the stationary gear, it makes but one-half turn on its own axis.

44.—Subscriber: In cutting threads on taper taps or plugs, should the tool be set square with the face of the work or square with the axis of the piece? 2. How do tool makers cut threads on pieces of tool steel that are to be hardened and obtain the correct number of threads per inch after hardening? The steel we use sometimes contracts 1/24th of an inch in hardening and consequently there are more threads in a certain number of inches than there should be.

A.—Set the tool square with the axis. See answer to question 35 in the February number. 2. Your difficulty is one that every one meets with and that there is no good way of remedying, so far as we know. That the tap manufacturers do not remedy it in their commercial product you are probably aware of, as the errors in pitch can frequently be detected by the aid of a common scale. Something may be gained by annealing the steel once or twice, taking one or more cuts between each annealing, and repeating the process for the last time before the final cut is taken upon the thread. The idea is to relieve the initial stresses in the surface of the metal as much as possible, which tend to warp or twist the piece, but this can have but little effect upon its contraction as a whole. Harden in pure water, immersing the tap, end first.

45.—J.A.C.: Will you tell me the proper way to harden a ball pene hammer made from Jessop's steel so that the center will be hard to prevent scratching.

A.—To harden a hammer so that the center will hold a polish, it will be necessary to harden it all over, a method which is not usually followed or recommended, as there is considerable danger of cracking through the eye. The hardening operation should be carefully performed, the hammer being uniformly heated and then plunged into clean cold water. When cold it should be slightly polished so that the changes of color can be followed when the temper may be drawn by suspending the hammer on a piece of red hot iron thrust through the eye. In this way the eye part will be drawn to a low temper before much change in the face or ball of the hammer can be seen. Thus you may be able to satisfactorily temper a light hand hammer, but it would probably not work well with the heavier ones. To harden a heavy hammer so that it will fulfill the requirements, you may be able to do it satisfactorily by hardening all over as described and drawing the eye part down to a purple. Then by carefully heating the face without raising the temperature of the eye, the face may be hardened and drawn at one operation. The ball pene may also be hardened and drawn to the proper temper in the same way. The proper color for a hammer face is commonly taken to be a light straw or just the first changes in color. A full straw color will usually give satisfactory results or even somewhat softer. We would not advise hardening a hammer all over as described, but if it be done, it should be given to an expert, who not only understands such work, but who is also an adept in the necessary manipulation—not a small part by any means.

46.—We have received two questions which we will submit to our subscribers for replies. The first is, "Where can I obtain fusible solder? I wish to solder some babbitt letters to cast iron. What kind of flux would you advise?" The second one is "Please give me the receipt for a solution for coloring bright brass a dull, fast black and the method for applying it."

47.—E. G. K.: In page 186 of the February number, Mr. W. H. Van Dervoort describes a method of boring a taper hole in a piece clamped to the face plate of the lathe, by means of a bar placed between the centers, the tail center being set over sufficiently to give the correct taper. Please explain how to calculate the amount to set over the tail center in order to bore any required taper.

A.—Prof. Van Dervoort shows three arrangements of bars for boring tapers, but with all of them the principle is the same. Whenever one end of the bar is on one center and the other end is off-set, the amount of the off-set should be enough to give the bar one-half the inclination per foot that the hole is tapered per foot. For example, if the hole were tapered one inch per foot, the bar should have an inclination of ½ inch per foot. If the bar were 2½ feet long, it would have to be off-set 2½ times ½, = 1¼ inches; if it were 17 inches long we should have, 17 inches = 1 foot 5 inches, = 1 5/12 ft. Hence, $1\ 5/12 \times \frac{1}{2} = \frac{1}{2} + 5\text{-}24 = 17\text{-}24 = .708$ inch.

48.—O.F.: If a stone or iron ball were dropped into the water, would it sink to the bottom, regardless of the depth, or is there a depth at which it would remain suspended?

A.—Suppose there were such a depth; for example, at the center of the Pacific Ocean. It is clear that all the earth and stones at the bottom of the ocean would then rise to this point and float about, forming a floating submarine island, and the ocean would be literally without bottom. The absurdity of such a condition makes it evident that the condition mentioned in your question could not exist. It is possible that some substance, having a specific gravity but slightly greater than that of water, might sink to a point where the water would be sufficiently dense, owing to the pressure of the water above, to have a specific gravity equal to that of the substance in question. If this were the case, the substance would float at this point. It is estimated that a cubic foot of water would increase in weight only about ½ pound at a depth of a mile, so nearly imcompressible is it. Assuming the weight of water under atmospheric pressure, only, to be 62.4 pounds per cubic foot, then, according to this, a body weighing 62.9 pounds and displacing a volume of one cubic foot would float, or remain suspended, at a depth of one mile. However, it would be nearly impossible to find such a substance, which at the same time should be incompressible, so that at the depth of one mile it would still have one cubic foot volume. If the body were compressed as much or more than the water, as is probable, it would continue to sink regardless of the depth, because its weight per cubic foot would continue to be greater than the water.

49.—G.S.: Please give me information in regard to the size that I should have to turn an axle for a street car wheel so that there would be a correct allowance for pressing together. The wheels have a 2⅞ inch hole. How many tons pressure would be required to press the wheel on the axle and would it be neces-

sary to taper the axle in order to start it? We have never done any work of this description, but want to begin to make street car repairs.

A.—In the data sheet issued with the September, 1898, number of MACHINERY, you will find a diagram showing how much to allow for force fits. For an axle 2⅞ inches in diameter this diagram calls for about .005 inch for forcing. If the hole is smooth and the axle nicely finished, this will be enough, but if the work is rough, as will probably be the case, you will have to allow a little more, perhaps .008 inch. If the wheel presses on with 25 to 30 tons pressure it will be sufficient. For simply pressing the wheels on their axles, a 50-ton press will be ample, but when it comes to removing wheels that have been in service for some time, the pressure required may be double what is required to put the wheel on and we should recommend a 100-ton press, if possible, and certainly not less than a 75-ton press.

50.—E.R.W.: Please explain how the reading is taken from an ordinary micrometer caliper and also how is a sliding jaw vernier caliper read?

A.—The principle on which the ordinary micrometer operates is very simple, being usually an accurately cut screw of 40 threads to the inch to which is attached a barrel that moves over a graduated line. The graduations correspond to the pitch of the screw, so they are 1-40 of an inch apart. The barrel is graduated on its circumference into 25 parts, so it is evident that when the barrel is turned through one graduation, the measuring points are approached or separated by 1-25 of 1-40" or 1-1,000 of

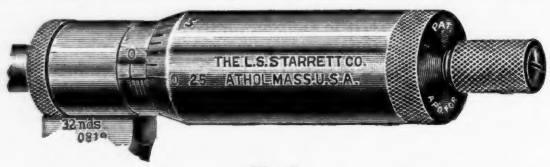


Fig. 1.

an inch. If the barrel should be turned so that seven graduations on the longitudinal line are exposed and the ninth graduation on the circumference of the barrel coincides with the line,the reading would be 7-40 + 9-1,000 or 184-1,000, since 7-40 = 7 × 25 or 175-1,000 and 9-1,000 being added gives 184-1,000 or .184". The reading of the Starrett micrometer barrel shown in the accompanying cut is slightly less than .100" since a little less than four divisions of 1-40" each are exposed. To illustrate the reading of the sliding jaw vernier caliper, we have reproduced the cut that appears in the Brown & Sharpe catalogue together with the accompanying description:

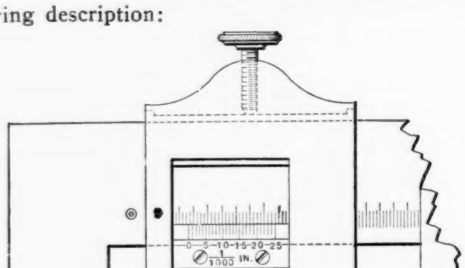


Fig. 2.

On the bar of the instrument is a line of inches numbered 0, 1, 2, etc., each inch being divided into ten parts, and each tenth into four parts, making forty divisions to the inch. On the sliding jaw is a line of divisions called a vernier, from the inventor's name. The vernier is divided into twenty-five parts, numbered 0, 5, 10, 15, 20, 25, which correspond, in extreme length, with twenty-four parts, or twenty-four fortieths of the bar; consequently each division on the vernier is smaller than each division on the bar by .001 part of an inch. If the sliding jaw of the caliper is pushed up to the other, so that the line marked 0 on the vernier corresponds with that marked 0 on the bar, then the two next lines to the right will differ from each other by .001 of an inch, and so the difference will continue to increase, .001 of an inch for each division, till they again correspond at the line marked 25 on the vernier. To read the distance the caliper may be open, commence by noticing how many inches, tenths, and parts of tenths, the zero point on the vernier has been moved from the zero point on the bar. Now count upon the vernier the number of divisions, until one is found which coincides with one on the bar, which will be the number of thousandths to be added to the distance read off on the bar. The best way of expressing the value of the divisions on the bar is to call the tenths one-hundred thousandths (.100), and the fourths of tenths, or fortieths, twenty-five thousandths (.025). Referring to the cut shown in Fig. 2, it will be seen that the jaw is open two-tenths and three-quarters, which is equal to two hundred and seventy-five thousandths (.275). Now suppose the vernier was moved to the right so that the tenth division should coincide with the next one on the scale, this will make ten-thousandths (.010) more to be added to two hundred and seventy-five thousandths (.275), making the jaws to be open two hundred and eighty-five thousandths (.285).

The following questions were answered by Wm. Baxter, Jr.

51.—J.O.P. Would the current be alternating or direct, taken from an electric generator consisting of a four pole rotating field, the armature being stationary and wound and connected the same as a Gramme ring armature? If alternating, what would be the winding and connections of the armature to obtain a direct current?

A.—If the armature were wound and connected with a commutator in the same way as in an ordinary generator, two alternating currents could be derived if four stationary brushes were located so as to press against the commutator surface ninety degrees apart. To obtain these two currents it would be necessary to connect the line wires to adjoining brushes.

If the opposite brushes were connected together by short wires and the line wires were connected with these, so that each line wire would be connected with the diametrically opposite brushes, one alternating current would be obtained. If the brushes be attached to the field, so as to rotate with it, the current will be direct, and one or two currents can be obtained by connecting the brushes with the line wires in the same way as with the stationary brushes.

52.—H.C.M. Will you kindly tell me how I can arrange an electrical gage on a water tank, by means of one wire, so that gage will indicate the depth of water in the tank, in feet at pump house, and at same time sound a magnet bell. It is desired also that the same device shall indicate depth of water as it recedes. The tank is 1,000 yards from the pump house.

A.—There are several ways in which such a gage can be arranged, but a full explanation would be too lengthy for this department. The most we can do is to outline the general principle. About the simplest way would be to arrange a float so that it would make electrical connection for different depths of water, one, two, three feet, etc., each connection placing in series in the line circuit a number of battery cells proportional to the number of feet of water. For example at one foot depth, one cell would be connected; at two feet, two cells in series, and for four feet, four cells in series, and so on for greater depths. At the receiving end, magnets would be arranged to ring bells and also to throw into view discs numbered to correspond with the depth of water in the tank. The magnets actuating these discs and bells would be adjusted so as to have sufficient force to act when the current was supplied by the proper number of cells but not with a smaller number. Thus if at four feet depth four cells were connected with the line, the magnet actuating disc four would be energized sufficiently to throw the disc, and so would all the magnets for lower numbers, that is, for 1, 2 and 3; but the magnet actuating disc 5, would not move.

The foregoing may help you to devise an arrangement that will work, but unless you are fairly well posted in electrical wiring, and the operation of magnets, we would not advise you to try it because to operate, the various parts of the system must be properly adjusted, and such adjustment cannot be obtained by any one who has not had some experience in such matters. Any electrical bell hanger, who has installed hotel annunciators, ought to be able to work out a simple arrangement that will accomplish the object in a satisfactory manner.

GAS ENGINE DESIGN.—5.

PISTONS, CONNECTING-RODS AND CRANKS.

E. W. Roberts.

Leaving the question of valves and their accessories until we have finished with the major parts of the engine, the proportions of the piston will now be considered. With a few unimportant exceptions, all gas engines employ a trunk piston with one end of the connecting rod pivoted on a pin fastened in the piston itself. This is done for the reason that great difficulty has been experienced with keeping the temperature of a piston rod at a point which will permit of its use without cutting. Several engines have been designed that employ a piston-rod successfully but they by no means represent general practice in the gas engine industry.

While the proportion between the length of the piston and the diameter of the cylinder, varies with the designer and is quite frequently the outcome of guess-work—popularly termed "judgment"—average practice appears to be to make the length of the piston one-third greater than the diameter, although a case is occasionally found in which the length is twice the diameter of the cylinder. Mr. Wm. Norris, an English writer on the subject, gives as a rule for the length of the piston, that the maximum pressure per square inch of projected area should not, in any case, exceed 20 pounds. In order to find what this pressure is, the writer will follow the graphical method suggested by Mr. Norris, and apply it to the indicator diagram Fig. 11, article 2. Taking the connecting rod as twice the stroke of the engine, the pressure upon the piston per square inch of cylinder area is found as shown in Fig. 20. First lay out the diagram D, and the distance AB—the length of the connecting rod—(twice the stroke in this case); then the distance BC = ½ the stroke. Describe the quadrant B E with the radius equal to C B. The arc may be continued to a half circle, if desired, to show the pressures on the piston throughout the stroke, but it is unnecessary to do so for this case, as the maximum pressure in this form of diagram will be found on the first half of the stroke. Erect the vertical lines a, c, d, e as close together as appears to be required and, from their intersections with the atmosphere line X Y, strike arcs cutting the quadrant B E with a radius equal to the length of the connecting rod. The method of finding the pressures at the various points of the stroke between the piston and the cylinder may be shown by a single example as when the piston is at the point a. To find the pressure at point a lay off the distance a b along the line X Y, which will locate the point b'; from b' erect the perpendicular b'm, meeting the line aa' at m. The distance b'm is that representing the side pressure of the piston on the cylinder wall, computed from the pressure per square inch as shown by the indicator diagram. The total side thrust of the piston would therefore be b'm X the area of the piston.

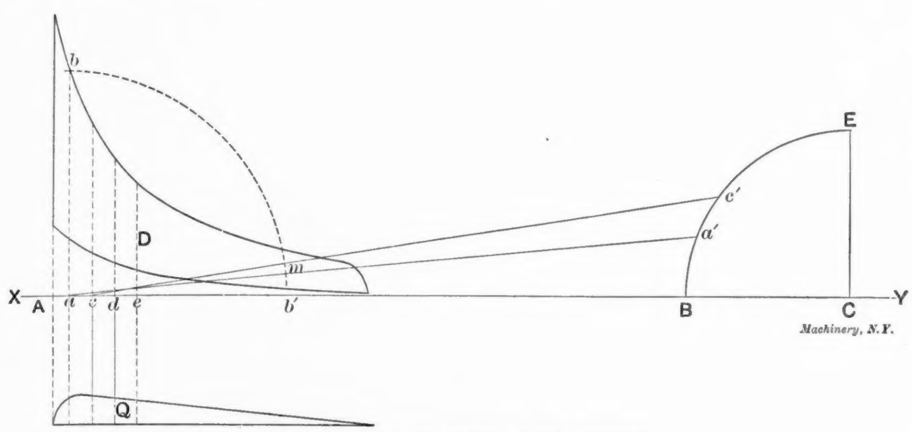


Fig. 20. Diagram for Finding Piston Pressure.

In order to simplify the calculation of the length of the piston, the writer has derived a formula in the following manner:

Let D = the diameter of the cylinder, in inches,

L = the length of the stroke, in inches,

p = maximum side pressure of the piston corresponding to the pressure upon one square inch of the piston area, (= value of line b'm in Fig. 20.)

Since the area of the piston is equal $\frac{\pi D^2}{4}$, it will then be evident from the previous paragraph that the total side pressure of the piston $= \frac{p \pi D^2}{4}$.

But the projected area of the piston is equal to DL and since the pressure per square inch of this projected area should not exceed 20 pounds, another expression for the total side pressure is 20DL. Placing these two expressions equal,

$$20\,D\,L = \frac{p \pi D^2}{4}\text{; or } L = \frac{p \pi D}{80} \qquad (19)$$

In Fig. 20 the highest pressure for p is found to be 32 pounds and substituting this pressure for p in formula 19, the equation becomes $L = \frac{32 \times 3.1416 \times D}{80}$; $L = 1.26$ D nearly, the result showing that the ratio L = 1 1-3 D is ample for these conditions which in practice are close to the average limit.

An example of a class of piston that is in use in many gas engines is shown in Fig. 21. The various proportions of the piston are based upon the diameter of the cylinder and are as follows:

A = .08D
B = .07 D
C = ½ B = .035 D.
E = .035 D + ⅛"
F = H = G = .04 D.
M = N = 2/3 D or ½ the length I
I = 1 1/3 D

The diameter R of the piston ring is usually from 1 per cent. to 1.5 greater than the diameter of the cylinder. For a six-inch piston this would give as the diameter of the ring 6 1-16' to 6 3-32". The thickness of the ring at S, its widest portion, should be about 1/16" greater than its width, or .035 D + 1-16", and the thickness at T should be about 2/3 S. The writer was once asked by the superintendent of a gas engine factory to calculate the shape of cross-section for a ring of this sort which would be of equal strength throughout, the width of the ring being necessarily the same at all points. Referring to any work on the subject of mechanics, it will be found that such a beam, if rigidly supported at the center, should have straight sides which taper to nothing at the outer end. It would, of course, be unpractical to make the ring of such a form and the writer was compelled to resort to practical experience in order to decide upon the best form.

In turning up a packing ring for a gas engine, the opening should be cut before the outside of the ring is finished to size. The ring should then be clamped in a jig with the ends sprung together. While in this position the ring should be turned to the same diameter as the bore of the cylinder. Only in this manner can a tight ring be secured that will successfully withstand the high pressures now in vogue in gas engine practice. The number of rings that should be used in a gas engine cylinder is a subject of some difference of opinion. It is not customary to use less than three rings in the smallest engines, and usually the number of rings is increased to four for sizes above 8" diameter. One of these rings is quite often placed as shown by the dotted lines at X, many gas engine builders claiming that it relieves the piston of pressure on the cylinder. As the piston is not in any case supported by the rings, the writer fails to see the force of such an argument, and believes that a ring in this position is of doubtful utility. Quite often five rings are found in pistons above 12" diameter. With the proportions given in Fig. 21, it would be necessary to move the piston-pin in case all five rings were placed at the head end of the piston.

In small pistons the web G is usually omitted and the piston constructed as shown by the dotted line. The extra thickness of metal at A, is for the purpose of preventing the first ring from becoming over-heated, and, in some engines, a wrought

iron plate is bolted to the head of the piston with an asbestos pad between the plate and the piston. Another attachment to the cylinder head is what is called a compression plate and is bolted to the piston head in case the engine is to run at high altitudes, where the pressure of the atmosphere is considerably below that found at the sea-level. It is best to attach these plates to a piston for altitudes exceeding 5,000 feet. It is as well to caution the designer against permitting projections of any sort upon the head of the piston or at any point within the compression space that is not subject to the cooling effect of the water-jacket. It is not generally known, but it is nevertheless true that considerable trouble is experienced with engines in which this precaution has been neglected. Where fuels having a low ignition point are employed, such as gases rich in hydrogen, gasoline and acetylene, this precaution should be doubled. Either the projections themselves, or deposits of carbon which collect upon them, become heated to a comparatively high temperature, with the result that

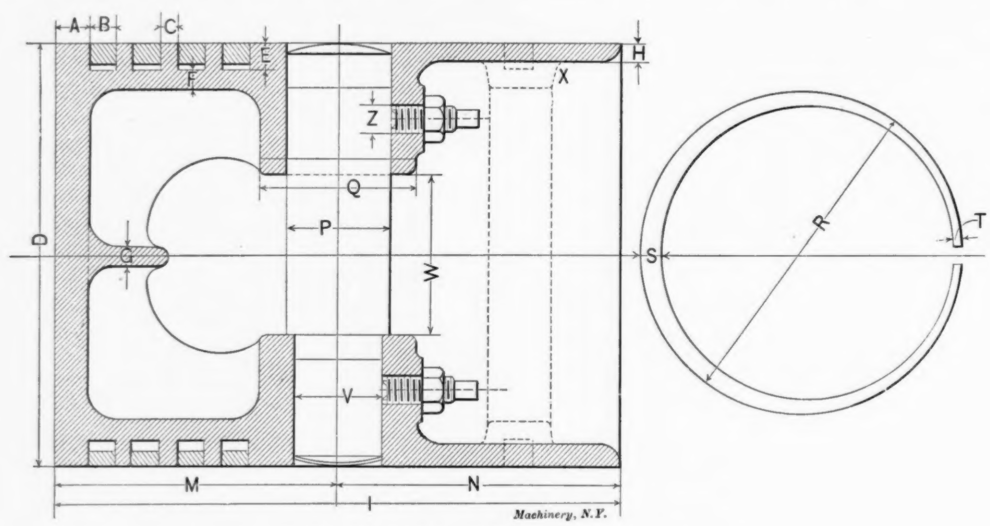


Fig. 21. Design and Proportions for Piston.

premature ignition takes place, sometimes as early as during the suction stroke.

The diameter and length of the piston-pin should be such that the total mean pressure upon the pin should not exceed 750 pounds per square inch of projected area. It is customary to make the length W the same as that of the crank pin in order that the brasses may be the more readily lined up. Considering therefore the length W as already determined, the diameter P may be found by means of the following formula:

Letting A = the area of the piston,

p = the mean effective pressure.

$$P = \frac{A\,p}{750 \times W} \qquad (20)$$

The metal at the outside of the piston assists in supporting the pin so the dimension Q may be made 1.5 P. A good proportion for the set screw Z is to make its diameter ¼ that of P. The diameter V should be enough less than that of the pin to make a good shoulder, the proportion shown in the figure being V = .8P.

With the exception of the smaller sizes, three horsepower and below, nearly all American-made gas engines are fitted with slab cranks. The general formulas for the diameter of a crankshaft are those given below:

Let S = the diameter of the crankshaft,

L = the length of the stroke in inches,

D = the diameter of the cylinder,

m = the maximum pressure within the cylinder,

$$S = .056 \sqrt[3]{m\,L\,D^2} \text{ for wrought iron.} \qquad (21a)$$

$$S = .052 \sqrt[3]{m\,L\,D^2} \text{ for steel.} \qquad (21b)$$

In case the length of the stroke is 1½ times the diameter of the cylinder, these formulas may be further simplified to:

$$S = .064\,D \sqrt[3]{m} \text{ for wrought iron} \qquad (21c)$$

$$S = .059\,D \sqrt[3]{m} \text{ for steel.} \qquad (21d)$$

In order to illustrate the application of these formulas, suppose it is necessary to compute the diameter of the crankshaft for an engine 16 × 24 and with a maximum pressure within the cylinder of 300 pounds per square inch. In this case the length of the stroke is 1½ times the diameter of the cylinder and formula 21d may be used if the shaft is to be made of steel, which is undoubtedly the best material. Substituting in the formula it becomes $S = .059 \times 16 \sqrt[3]{300}$. The cube root of 300 may be found from a table of roots and is 6.6943, the first two figures of which are sufficient for the purpose, and .059 × 16 × 6.69 = 6.3, say a 6¼ shaft. For wrought iron, the shaft should be .064 × 16 × 6.69 = 6.88, say a 6⅞ shaft.

Take the same size cylinder but with a stroke of 20", and for steel it becomes necessary to employ formula 21b giving the equation $S = .052 \sqrt[3]{300 \times 20 \times 16^2}$, the product under the radical sign becomes 300 × 20 × 256 = 1,536,000, and the cube root of 1,536,000 is 115.38, .052 × 115.36 = 6. For wrought iron the shaft should be .056 × 115.36 = 6.45, say, a 6½ inch shaft. In either of these computations the decimal .36 may be dropped and the three first figures 115 employed. The reader is asked to remember that the writer is still using the slide-rule for these computations.

The diameter of the crankpin should be made at least 1⅛ times that of the shaft. The diameter of the pin for the 16 x 24 engine using a steel shaft would be 6 × 1.125 = 6¾. The projected area of the pin should be such that the maximum pressure upon it does not exceed 400 pounds per square inch, and in order to determine the length of the pin, the diameter being known, employ the following formula:

Let q = the diameter of the pin,

f = the length of the pin;

A and p as in formula 20;

$$\text{Then } f = \frac{A\,p}{400\,q} \qquad (22)$$

In this example just cited, to find the length of the pin, the proper substitution in the formula, calling the M.E.P. 75 pounds, gives

$$f = \frac{201 \times 75}{400 \times 6\,75} = 5.64 \text{ say } 5⅝.$$

Continuing with the same engine compute the diameter of the piston pin by means of formula 20. The length of the pin will

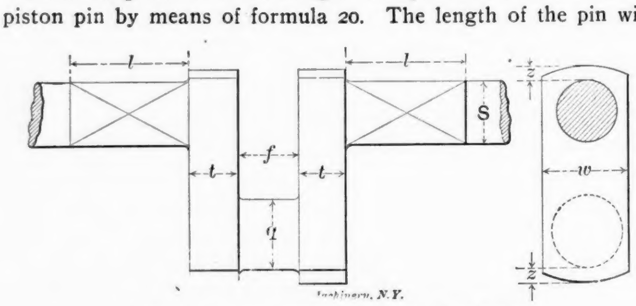


Fig. 22. Proportions of Crank and Crank-pin.

be taken as 5⅝, or the same as that of the crankpin. Substituting in the formula:

$$P = \frac{201 \times 75}{750 \times 5.625} = 3.6 \text{ say } 3⅝'' \text{ diameter for the piston pin.}$$

The reason for allowing so much more pressure upon the piston pin is that it is not subjected to the amount of turning movement that occurs with the crankpin.

So much difference of opinion exists regarding the amount of pressure to allow on the crankpin journals, and the figures for this purpose are so wide apart, that the writer has decided to give a proportion for the length of the crankshaft journal. The

average practice in the United States appears to be, to make the length of the bearing 2 to 2.5 times the diameter of the crankshaft, denoted by l in the Fig. 22. The remaining proportions are as follows:

$t = .8s$ (23)
$w = 1.4s$ (24)
$z = .2s$ (25)

If, as is often the case, a gear is placed between the bearing and the crankweb, a space must be allowed for it. It is quite convenient when erecting the engine, if the shaft be turned about .005" larger where the gear is placed than for the remainder of its length, in order that the gear may be slipped over the shaft until it reaches its position and then be put in place with a snug fit. Quite often the crankpin is oiled by means of an oil-hole drilled through the center of the pin and out to the surface. A small tube is used to connect this hole with a collar on the shaft and the oil is distributed by means of the centrifugal force.

The connecting rod of a gas engine is not the least important feature, and many an engine has been hopelessly wrecked by an ill-designed or defective connecting rod. The writer remembers a case in point where a fifty horse-power engine returned to the factory in a deplorable shape, the rod having broken in the middle with a clean fracture, denoting that the material was not to blame. The designer confessed in a shamefaced sort of way, that he "kinder didn't figger it." Further investigation proved that the engine had been designed and built in haste, and that the rod used was originally intended for a forty horse-power engine.

The following formula will be found to give ample dimensions for connecting rods made from mild steel. The mean diameter of the rod is taken as half the sum of the diameters of the two ends:

Let r = the mean diameter of the rod.
D = the diameter of the cylinder.
l = the length of the rod between the centers of the pins in inches.
m = the maximum pressure in the cylinder.

Then $r = .035 \sqrt{D\,l\,\sqrt{m}}$ (26)

As this formula is a somewhat puzzling one for some to handle, the writer has deduced the following modifications for cases in which the stroke of the engine is 1½ times the diameter of the cylinder, L being the length of the stroke in inches.

When $L = 2\,l$, $r = .06D\sqrt{m}$. (26a)
$L = 2.5\,l$, $r = .068\,D\sqrt{m}$ (26b)
$L = 3\,l$, $r = .074D\sqrt{m}$. (26c)

A further simplification of these formulas for the various maximum pressure in use may be made, and they may be brought to the form r = FD. (26d).

The values of F for the different values of and for the three proportions of l to L are shown in the following table:

	When l = 2L.	When l = 2.5L.	When l = 3L.
m =	F =	F =	F =
240	.236	.268	.291
280	.245	.277	.303
320	.253	.288	.313
360	.261	.296	.322
400	.268	.304	.331

If the proportions of length and the maximum pressure to be employed vary from those given in the above table, the next higher value should be taken. The proportions derived will be very close to the correct result.

It appears to be the most common practice in gas engine construction to use a connecting rod of the marine type, as shown in Fig. 20. The proportions for the various parts of the rod and the brasses are based upon both the diameter of the rod and the diameter of the pins. In Fig. 23. the mean diameter of the rod is marked r, the diameter of the crankpin q and the diameter of the piston p. These proportions are:

$a = 1.2\,r.$ (27)
$b = .285\,r$ (28)
$c = .5\,q$ or at least $.8r$ (29)
$d = .6\,P$ or at least $.5r.$ (30)
$j = k = .85\,P$ (31)
$r = s = .85\,q$ (32)
$m = .17\,P$ (33)
$n = .17\,q.$ (34)

Dotted lines at f and g show short projections from the ends of the rod into the brasses for the purpose of holding them in line. Quite often the projections are on the brass and the hole is bored in the end of the rod, but the method illustrated is much simpler to make, as the projection on the rod may be turned in the lathe and it is much easier to bore the hole in the brass than in the rod, as any one who has run a lathe will probably see. The proportions given above are intended merely as a guide to the designer, and are derived from tables of dimensions of gas engine connecting rods which are in daily use. The taper of the rod or

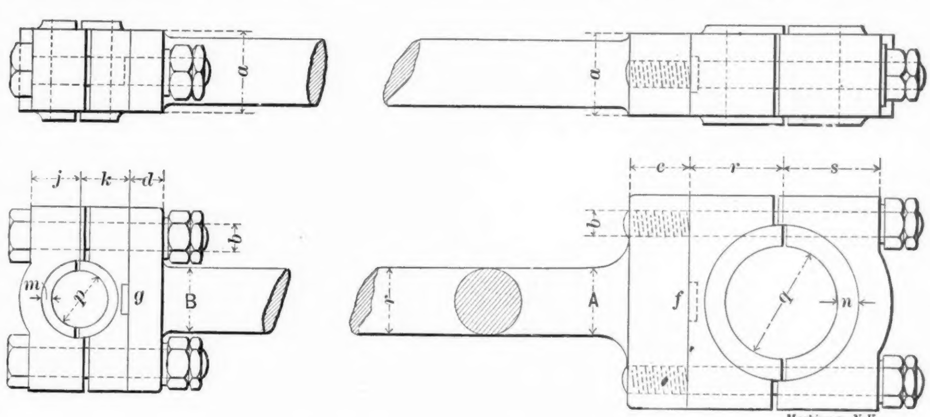


Fig. 23. Marine Type of Connecting-rod.

the difference between the diameters at A and at B is about ⅛ inch to each foot of length between centers.

The application of formula (26d) may be shown by means of the following example: Suppose it is necessary to find the mean diameter of a connecting rod for a 20 x 50 engine, when the length of the rod is 70" center to center, and the maximum pressure is 300 pounds. The length of the stroke being 1½ times the diameter of the cylinder, the formula 26 d will apply. The pressure is not given in the table, nor is the ratio of the length of the rod to the stroke, which is 70 ÷ 30 = 2 1/3. If it is desired to get very close to its correct value it may be done by interpolation as follows: First, find two values for F corresponding closely to 300 pounds in the columns l = 2L and l = 2.5L. As 300 is half way between 280 and 300, take half the difference between the values opposite these figures and add them to the values opposite 280. Half .253 — .245 is equal to .004 and .245 + .004 = 249; .288 — .277 = .011 and half of .011 is .0055, say .006; .277 + .006 = .283. These are the figures that correspond very nearly to the values of F when the pressure is 300 pounds and when l = 2L and l = 2.5L respectively. The ratio 2 1/3 is 3/5 of the way between 2L and 2.5L, and to get the right value of F for this ratio, take 3/5 of the difference between .249 and .253 and add it to .249. This difference is .034 and 3/5 of .034 is nearly .021. Hence the value for F is .249 + .021 = .27. The formula then becomes r = .27D and since D = 20", r = .27 × 20 = 5.4", say 5⅜ or 5½ inches.

* * *

WONDERFUL AXLE.

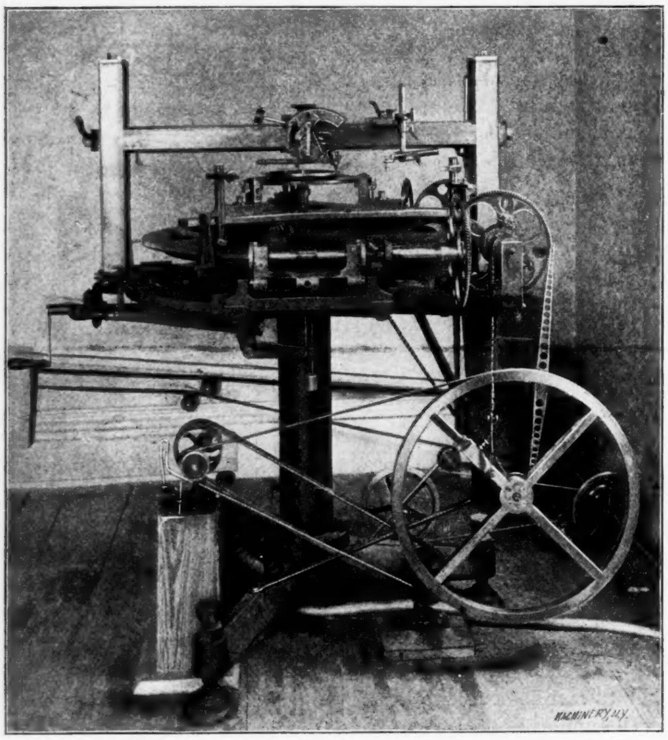
(Special Cable to the N. Y. Herald.)

Paris, Thursday.—A big locomotive is nearly ready for the Northern Railway. It is twenty metres (sixty-five and a half feet) long, and has five axles, of which two are forward, two driving and a big axle at the rear, which, it is claimed, gives great speed.

Attached to it is a tender having four wheels and carrying 6,000 kilos (six and three-fifth tons) of coal and twenty cubic metres (706 cubic feet or 4,402 gallons) of water.

AN AUTOMATIC DIVIDING ENGINE.

The advance made in astronomy, and in civil engineering during the last two centuries, has been made possible by the perfection of the telescope, the fine and accurate graduation of the circle, and the skill applied in the combination of metals in the construction of instruments of precision. The demands of the users of instruments have taxed the ingenuity of the makers, constantly requiring greater perfection, and the greatest difficulty has been to divide the circle accurately into degrees, minutes and seconds. It is only within recent years that machinery has been constructed that will do this graduation work with almost absolute accuracy, and at the same time automatically. To-day there are less than a dozen first-class dividing engines in America.



A Machine that will Divide within Two Seconds of an Arc.

In a recent number of the "Engineering News" was an article by C. L. Berger, Boston, Mass., containing a description and illustration of a dividing engine designed and constructed by William Wurdemann, Washington, D. C., and now in possession of Messrs. C. L. Berger & Sons, Boston, Mass. From this article the accompanying notes are taken and we are indebted to the "Engineering News" for the photograph from which the illustration is made. This dividing engine is worthy of note, not only because of its novelty, but because of the accuracy attained in its use. It is claimed for it that it will divide a circle within an error of two seconds of an arc, or, expressed in clearer terms, this error, if laid out on the arc of a circle four miles in diameter, would amount to but one inch.

On the main iron circle of the engine is inlaid a silver ring graduated to 10 minutes of arc, a space corresponding to one of the teeth on the edge of the circle. This graduation can be controlled by four micrometer-microscopes for verification of the work of the engine. The circle is moved by a tangent screw gearing, one revolution of which moves the main circle 10 minutes of arc. A drum head on the tangent screw is graduated into 120 spaces, which permits the movement of the circle in arcs of 5 seconds. The driving screws are employed, geared together so as to move in the same direction and at the same speed, and arranged on opposite sides of the circle. Driving the circle by two screws tends to divide and equalize any errors or differences arising from slight imperfections in the gear teeth or screws. In consequence of the greater contact surface between the moving screws and the engaging teeth of the screw there is less pressure and friction on the part of the circle engaged by the screws, and the bearing is relieved of side pressure.

With this engine, circles can be graduated in spaces of degrees, and 30, 20, 15, 10, 5 or 2'. Circles are either read by micrometer-microscopes to single seconds of arcs, or to 5, 10, 15, 20 or 30", according to the fineness of the graduations, by the use of verniers; or by a special vernier to hundredths of a degree, instead of minutes. On top of the graduating circle is placed the centering apparatus, whereon the circle to be graduated can be mounted and truly centered and clamped, so that each circle will truly coincide with the vertical axis of the dividing engine. This is accomplished by a spirit level reading to single seconds of arc. To graduate a circle to half-degrees requires about three hours; if a finer graduation is required a correspondingly longer time is necessary. The whole engine is so arranged that it works automatically. It is driven by an electric motor and requires no personal attention when once started.

The axis of the circle is of novel shape; it is a perfect cylinder where it is attached to the circle, and ends below in a hard steel cone which bears the weight. The effect of this long cylindrical axis is that the circle turns with uniform ease under all conditions of temperature. The axis enters a cast-iron column, into which its upper end is perfectly fitted, so as to turn easily without any possible shake. The column is supported on a cast-iron tripod with leveling screws that step into iron cups. The engine is made of iron and steel and the most important parts are hardened. The circle and its bearings are of hard cast-iron, a dense metal, with a small coefficient of expansion by heat which reduces to a minimum the variations due to changes in temperature.

* * *

In a recent paper, read before the Engineers' Club of Philadelphia, John Birkinbine presented many interesting facts relating to the utilization of waste products, one of which has special interest for tin-plate manufacturers. Mr. Birkinbine says: "The possibilities of utilizing waste in a single direction were suggested by a visit to a large button works in Connecticut, where I was informed that 90 tons of buttons had been made in one month. The material used to produce these buttons was the remnants of the sheets of tin plate from which the bottoms and caps of cans for blacking and other boxes had been cut. After the button blanks had been punched from this tin-plate the small triangles of metal connected by iron threads were compressed in a form under a drop-hammer, and subsequently shipped away to be made into sash weights."

* * *

ABOUT ARMAMENT AND ARMOR PLATES.

During the exercises celebrating the seventy-fifth anniversary of the Franklin Institute of Philadelphia was an address by Rear Admiral Melville upon the modern warship. In the course of his address, which has recently been published in the "Journal" of the Franklin Institute, reference was made to the guns and armor of our modern ships. He stated that a 12.5-inch breech loading rifle 50 calibers long, and weighing 83 tons, will propel a shell weighing 880 pounds, by a powder charge of 624 pounds, at a velocity of over 2,620 feet per second, giving an energy at the muzzle of over 40,000 foot-tons, capable of penetrating at the muzzle over 45 inches of iron. This energy means that one of our battleships of about 12,000 tons displacement, and which could carry four of these guns, would at a single discharge develop a power sufficient to lift her bodily nearly 15 feet. It can readily be imagined, therefore, what the effect of a projectile from one of these guns would be when striking another vessel at close range.

It is an extremely interesting story to read of what has been appropriately styled the "duel between guns and armor." As fast as one is improved so that its victory over the other seems assured, some inventor comes to the front with an improvement in the latter, which for a time puts it ahead. The armor on our monitors during the Civil War consisted simply of a number of one-inch plates bolted together. At the present day, a modern projectile would go through such armor as easily as a bullet penetrates pine boards, but long ago it was discovered that a given thickness of armor was much more efficient if rolled in a solid plate, and this was developed until some of the older English battleships had iron armor as thick as 24 inches. The development of the gun soon showed that it was impossible to keep pace with it by mere additions to the thickness of the simple armor, for a point was quickly reached where it was impossible to

carry the necessary weight of armor that would be thick enough. Then came the use of special plates, the compound armor, where a hard face to break up the projectile was welded to a softer back to give the necessary strength. This was followed by steel armor, and then by the well-known Harvey process, which resembled the compound armor in having a hard face with a softer back, but where the plates were made from a single ingot without any welding. The Harvey process enabled an enormously greater resistance to be obtained with a given weight of armor, but even it has been surpassed by the Krupp process, which enables 12 inches thickness to give the same resistance as 15 of Harveyized plates.

The tendency just now in naval design seems to be in the direction of having only one class of armored vessels which will be very powerful armored cruisers with good armor protection and high speed. This means a vessel of about 12,000 to 14,000 tons displacement, with 8 to 10 inches of Krupp armor, a battery of 10-inch rapid fire guns and a speed of about 20 to 21 knots.

In connection with this subject it will be interesting, also, to quote from a paper that recently appeared in the Proceedings of the Engineers' Club, Philadelphia, with regard to armor plate. The Krupp gas process, as it is called, is a secret process and the rights of its manufacture must be obtained through the famous Krupps of Essen. Krupp armor shows remarkable toughness combined with all the hardness of the best face-hardened armor; and, unlike armor manufactured by other well-known processes, the Krupp product maintains these qualities in the very thickest armor. The thickness of the hardness of Krupp's process is about 1.7 to 2 inches.

The Harvey process consists of the introduction of carbon by cementation into the face of an ordinary low carbon-steel plate, and subsequently it is water-hardened similar to an ordinary tool. After this treatment it presents a hard-faced surface to the depth of about one inch, designed to stop and break up projectiles before serious penetration takes place.

As armor plates must necessarily be secured to the frame work of a vessel to hold them rigidly in place, a serious difficulty is met with. In order to secure the plates, they must be drilled and tapped, and while this can be done before hardening, it is impossible to do it after hardening by any known means, until the plate has been annealed. Drills of every design and method of tempering have been tried, but with no success; the plates cannot be drilled without annealing. The question of being able to anneal the spots was thus becoming a serious matter; but, as many times before in other work of difficult character, the subtile fluid was the only agent that solved the problem, so also in the case of taking the temper out of certain spots to permit the drilling of holes in the harveyized plates, electricity came to the rescue on the eve of despair and failure. The Thomson Electric-Welding Company of Lynn, Mass., made some experiments on harveyized plates, and very soon demonstrated their ability to anneal any surface however hardened, by sending a current of large volume through any spot to be annealed, and by this means raising the temperature of the spot to about 1000° F.; and at that temperature there can be little doubt that the temper has been withdrawn.

The interesting operation of annealing a plate is performed in the following manner: The transformer is placed in position, the contacts touching the plate on either side of the spot marked for annealing. Then the primary current is brought up by means of the rheostat, near at hand, to from eighty-five to ninety-five amperes for a period of from four to five minutes. The metal between the two contact places soon attains a dull red heat, and this temperature is experimentally found by holding a small pine stick in contact with the spot until it takes fire. This is the maximum temperature desired to anneal the spot properly. The current is now gradually diminished by turning the rheostat handle one point each minute until all the resistance is placed in circuit, and by this method the spot is gradually cooled and the chilling of the plate prevented.

By a simple process it is possible to harden the spots again, except that in this case the current is turned from the contact points suddenly, which causes a hardening instead of an annealing action.

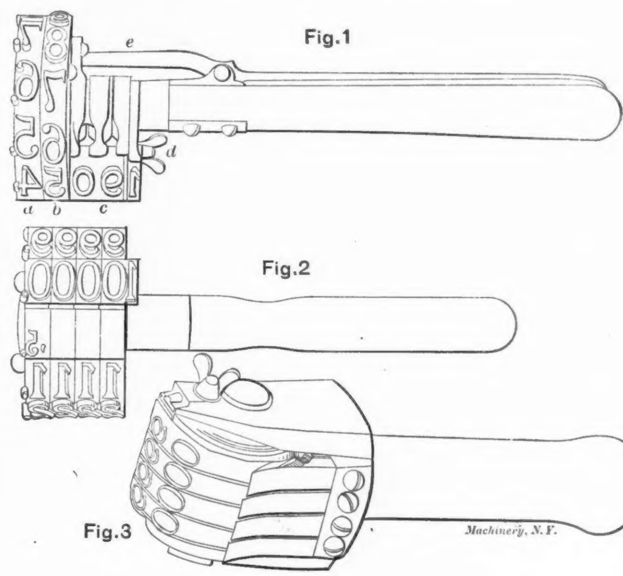
NUMBERING HAMMER.

ROBERT GRIMSHAW.

In the forest and lumber yards of Germany and Austria there is used a style of hammer for marking logs and boards with consecutive numbers, which might prove advantageous to pattern shops for marking patterns, and in shipping departments of large manufacturing establishments sending out great quantities of small cases.

The first style has a head with two number-wheels, each bearing digits 0 to 9 inclusive. The thousands, tens of thousands and hundreds of thousands not being so often changed, are not on wheels but on separate pieces c, which are changed as often as necessary by removing the thumb-nut d. Pressing on the latch e, which lies along the handle, permits turning the wheels a, b. This device numbers up to 19,999. Common printing ink is used. The numbers are about an inch high, and are deeply and sharply cut at their edges so as not to require great force to make a deep, sharp impression.

A simpler contrivance is shown in Fig. 2, which has four wheels and numbers up to 10,999, and a stationary "1," and will also print a decimal fraction 0.5 at a separate blow.



Both these hammers permit of a heavy blow and make a deep impression. Where, however, it is required to make but a light impression, or to make either a light or a very hard blow in a particular place and with greater regard to the direction in which the numbers lie, the four-wheel punch style shown in Fig. 3 is used.

This has a figure for the one hundred thousands, which may be rolled into place and held there when desired; the other numbers are on wheels held by a latch. There is, so far as I know, no patent on the first two styles; on the third only one German "Geschutz Muster" protection.

I suggest that the first may be improved by the addition of a back head, which would not only give greater force to the blow, but permit the use of the tool on very hard woods and in confined places where great exactitude of position is necessary, as it may be placed on the spot where it is desired to number and be struck with a mallet.

* * *

It is difficult to realize that the woman who sent the first telegraphic message—that is, the first practical telegraphic message, as we now understand the term—died only last month. Telegraphy is such an everyday affair to most people nowadays that it seems almost incredible that the person who dispatched the very first message should have just died. Mrs. Smith was not a very old woman—she was 72—but her lifetime spanned a period of marvelous industrial development, and from her father's friendship with Morse she was accorded the unique distinction of sending the first message. The event became historic and made the young girl share in the honors of telegraphy for all time.—Western Electrician.

LETTERS UPON PRACTICAL SUBJECTS.

INDEXING ON THE MILLING MACHINE.

Editor MACHINERY:

There is scarcely a machinist or apprentice who is not interested in the milling machine, which is an indispensable tool in the machine shop. While many of the readers of MACHINERY are familiar with the subject of indexing, there are probably those among the younger ones, to whom a few words on the principle of indexing may prove interesting. The dividing shaft of the indexing head on a universal milling machine usually makes 40 turns to one of the spindle, so that if we have a gear of 40 teeth to cut, one turn of the crank is necessary for each tooth. For any required number of divisions, the shaft should be turned 40/x turns. Thus for 8 divisions 40/8 = 5 whole turns. Again for 80 divisions 40/80 = ½ turn. If it is required to cut a 25-tooth gear 40/25 = 1 15/25 = 1 3-5 turns. Now, looking over the index plates furnished with the machine, for a circle of holes which can be divided by the denominator of the fraction (in this case 5) either 15, 20, 25, etc., would do. Suppose we find one of 20 holes, then 20/5 = 4 and 4/4 × 3/5 = 12/20; then, one complete turn and 12 holes would be the required division for each tooth. Sometimes an odd division is required which cannot be obtained in the usual way, by the index plates furnished with the machine. In cases of this kind the problem can usually be solved by differential or compound indexing. Thus, for a gear having 69 teeth, if there be no index circle of 69 holes, the division may be obtained by differential indexing; that is, by using the back stop pin in one circle of holes, and the front pin in another. Thus, 40-69 = 63-69 — 23-69 = 21-23 — 1-3, then by moving the crank 21 holes on the 23-hole circle, and then leaving the front or crank pin in its hole, in the index plate, take the back or stop pin out and move the plate and spindle backwards, 5 holes in the 15-hole circle, or 6 holes in the 18-hole circle, or 7 holes in the 21-hole circle, according as to which is used. This will give the required 40-69th of a turn of the dividing shaft. Again, suppose there is a gear of 81 teeth to be cut, and no index circle of 81 holes at hand. This may necessitate going around with the spindle a number of times, say 10. 81-10 = 8 1-10, then for each time around there would be 8 1-10 divisions. We could prove this graphically by drawing any circle of convenient diameter and dividing it into 8 1-10 divisions. Then, by stepping around the circle 10 times, there would be 81 equal divisions. After calculating and looking over the index plates, we may find the nearest approximation to be 5 5-41 turns — 9-49 of a turn; that is, 5 complete turns and 5 holes on the 41-hole circle, and backward 9 holes on the 49-hole circle. That the error in this is slight can be easily shown. Thus, $5\frac{5}{41}-\frac{9}{49}=4\frac{1885}{2009}$ and $\frac{40}{4\frac{1885}{2009}}=40\times\frac{2009}{9921}=8.09999+$ and $10\times 8.09999+ = 80.9999+$. It is apparent that this variation is so small as to make no practical difference.

The accompanying views in Fig. 1 show the construction of the Brown & Sharpe index head, the crank-shaft and worm being indicated by O and A, the stop-pin by P and the back stop-pin by R. Fig. 2 shows how we made the back stop-pin of our machine fit into four circles of holes. A circle of holes that we desired to use came to one side of the back stop-pin; so a segment was riveted on to the face of the pin R and a hole drilled through it of the same size as the holes in the index plate. A removable pin p was used instead of the back stop-pin, which was pushed out of engagement with the index plate. The pin p was removed when moving the index plate and then pushed through the plate into the hole in the riveted piece b.

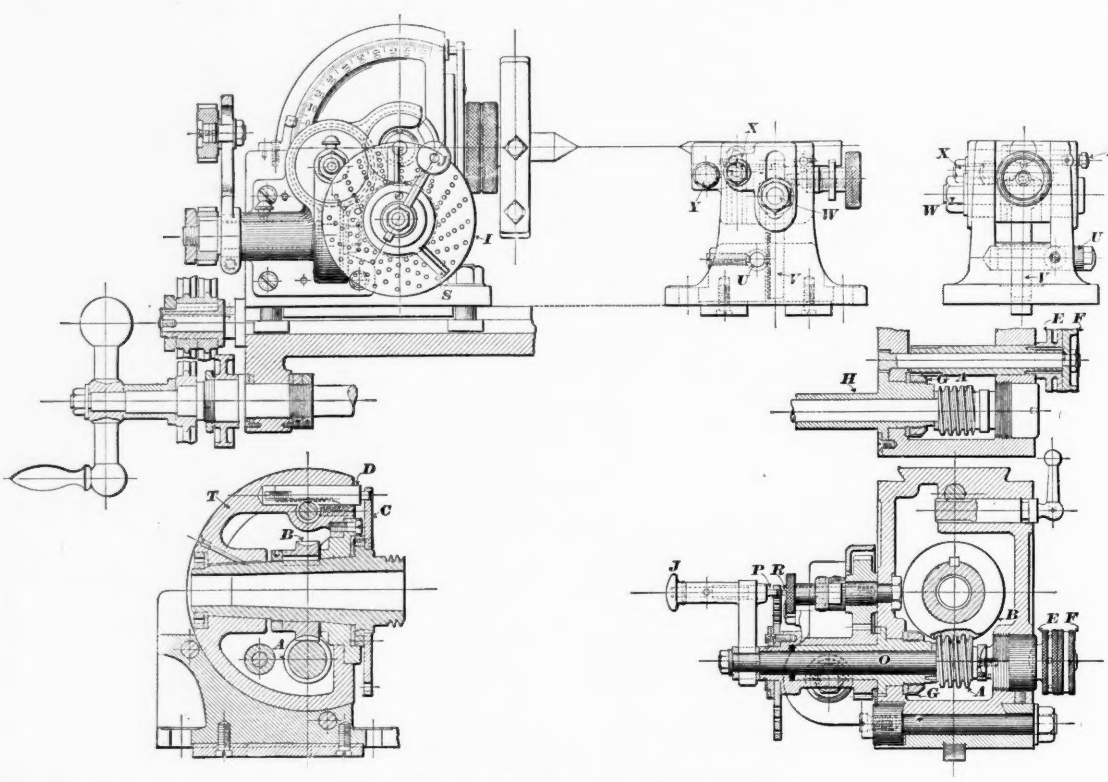


Fig. 1. Details of Brown & Sharpe Index Head.

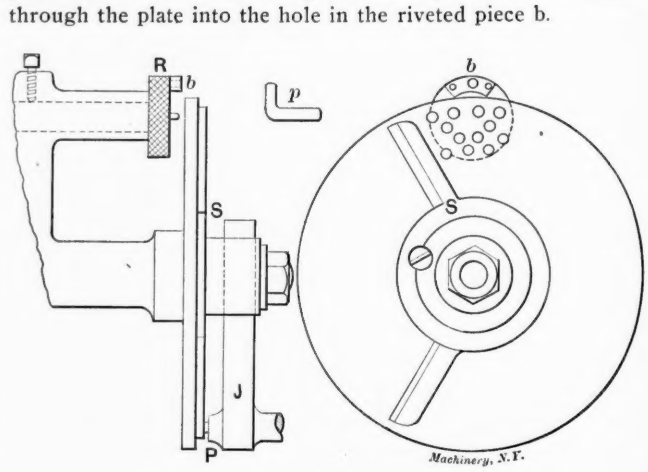


Fig. 2. Attachment for Compound Indexing.

The method of compound indexing is pretty thoroughly explained in Brown & Sharpe's "Treatise on Milling Machines," which gives solutions that require the index plates furnished with their machines mostly. Compound indexing admits of a

variety of solutions. It might be interesting if some of the readers of MACHINERY would contribute upon this subject.

JOHN T. GIDDINGS.

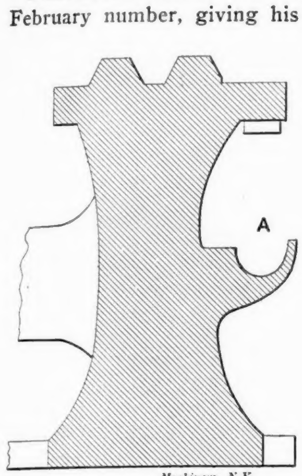
East Providence, R. I.

* * *

METHOD OF SUPPORTING LEAD SCREW ON OLD LATHE.

Editor MACHINERY:

I have read with much interest Mr. F. Emerson's article in the February number, giving his method of supporting long lead screws on a lathe, and possibly a method I have seen in use for accomplishing that end may interest him and others.



Section of Lathe Bed Showing Method for Supporting Lathe Screw.

A long trough A was cast integral with the front of the bed, as shown in the sketch, and the lead screw laid therein. The trough being the same length as the threaded part of the screw and of the same internal diameter, the screw was thoroughly supported. It had the usual bracket bearings at the ends. The nut was like an ordinary split nut without the lower half, the upper half being worked by a lever in the apron in much the usual manner. The lathe is in use every day at the present time.

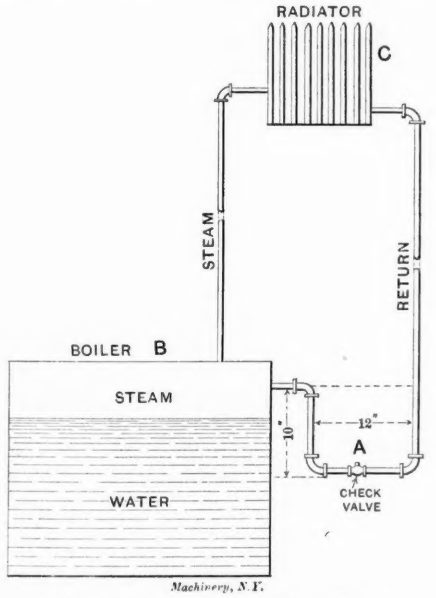
McKeesport, Pa. E. J. H.

* * *

TO PREVENT RADIATORS FILLING WITH WATER.

Editor MACHINERY:

I had the same trouble with my steam-heating plant as mentioned by H. H. in question 33 in the January issue of MACHINERY and show him, in the accompanying diagram, how he may overcome the difficulty. If he will pipe his boiler and radiators as



Piping for Heating Boiler and Radiator.

shown so that a trap is formed in the return pipe at A and have the return pipes inclined throughout their length towards the pocket, the circulation will be in the right direction and the radiators will keep free from water. F. H. NEAL.

Meadville, Pa.

* * *

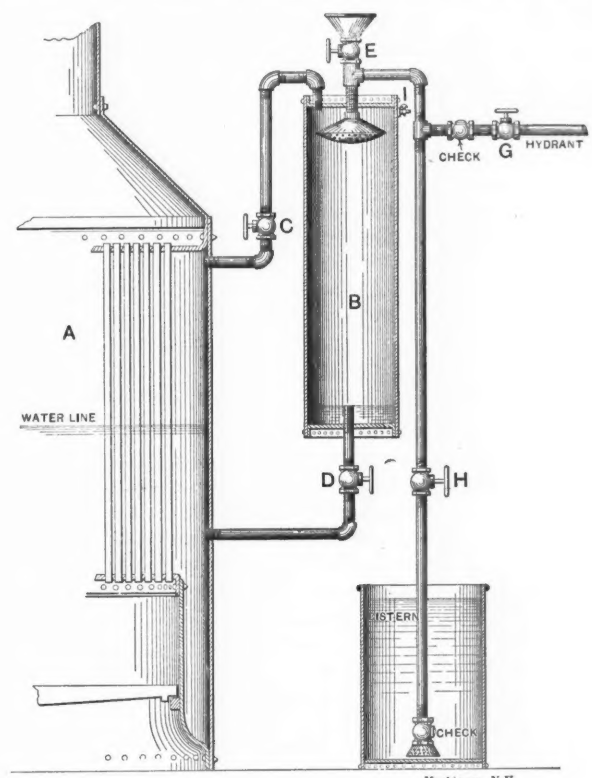
A GRAVITY SUPPLY FOR STEAM BOILERS.

Editor MACHINERY:

To the readers of MACHINERY I submit a novel method of supply for steam boilers with feed water, while under pressure. The principal feature of this device is its simplicity. It is easily applied and manipulated. It is excellent for laboratory purposes where the absence of the pulsations of a pump or injector is a factor. For experimental work in steam and hot water, or in compounding and mixing under high pressures and temperatures, it will be found a safe and reliable arrangement.

In the annexed sketch, A is the boiler to be supplied with water, while under high pressure; B is a reservoir made sufficiently strong to stand the boiler pressure, the bottom of which is placed at or above the water line in boiler; C is a valve in the steam pipe leading from the boiler to the top of the reservoir; D is a valve in the supply pipe leading from the bottom of reservoir to the boiler below water line; E is a valve with funnel for charging the reservoir; G and H are valves on the supply pipes from the hydrant and cistern; I is an air cock to allow the air to escape from the tank while charging.

To operate this gravity device, first charge the tank, either through the valve E or from the hydrant and, when full, close the valve E. If you wish to use the hydrant, leave the valve G open and if the cistern be used, open the valve H and close the valve G. After steam is generated and feed water is required



Gravity System for Feeding Boilers.

open the valve C on steam pipe, which allows the boiler pressure to enter the reservoir, thus equalizing the pressure and closing the checks on the hydrant, or cistern pipes, as the case may be, then open the valve D, in the supply pipe. The water in the reservoir being under the same pressure as that in the boiler, and above its line, will flow by gravity into the boiler, thus supplying it with the amount that is in the tank. Then close the valves C and D. The steam remaining in the reservoir will condense and form a partial vacuum which will allow the water to flow in from the hydrant pressure or, by atmospheric pressure, from the cistern. The water in flowing into the tank passes through a douche or jet which sprays the water and condenses whatever of vapor remains in the reservoir. This operation can be continued as long as there is steam in the boiler. I have demonstrated the practical utility of this device on more than one occasion, and it needs only a trial to be properly appreciated. GEO. C. STANLEY.

Norfolk Navy Yard.

* * *

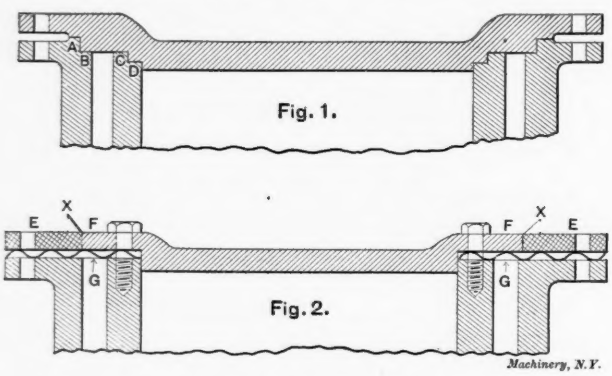
DRAFTSMAN VS. SHOPMAN.

Editor MACHINERY:

Without the slightest intention of stirring up any discussion or ill-feeling between the shop and drafting room, I show the design of a draftsman who, though a splendid fellow and very bright, had never had shop experience nor much outside work. As will be seen, it is the head of a jacketed cylinder.

The original drawing called for the joints A B C and D in

Fig. 1 and, while these are easy to put on paper they are a trifle more difficult to make in the shop; and, even if made, the unequal expansion raises Cain with them when they are in service. The shopman kicked right away, on account of the expense it would be to make these joints and his experience told him they would not stay tight; so a perfectly flat head was substituted. This, however, wasn't a howling success and finally Mr. Shopman suggested the head shown in lower cut, Fig. 2. The cylinder is faced off perfectly flat and the main head F is also perfectly



Double Head for Cylinder.

flat and extends to X X. This is bolted down as shown, but under this, and extending clear to the outer edge, is a copper gasket G, preferably slightly corrugated. The outer ring E slips over or around the main head and is also bolted down on the copper gasket. This allows for any expansion, makes a tight joint and has been very successful.

FRANK C. HUDSON.

* * *

THE CIRCUMFERENCE OF ELLIPSES.

Editor MACHINERY:

Has any reader of MACHINERY, in laying out elliptical gears or some other job, ever wanted to know the length of the circumference of the ellipse? And did he then try to figure it out and find that the authorities differ so much as to compel him to step it off with a pair of dividers? If so, he may appreciate the short way given by the diagram, one that requires no figuring, either. It's easy; just try it once by following the instructions and example worked out on the diagram itself with dotted lines to help steer a clear course.

This diagram is also a whole table of circle circumferences, because a circle is only an ellipse whose diameters are all equal. The top slant line, ratio 1, is to be used for the circle.

While the scales are marked 1 to 10 and 1 to 32, they are really good for any figures; the 1 may be read as 10, 100, 1000, or fractional as 0.1, 0.01, etc. Of course, whatever ciphers are added must be added to all the other figures in the scales.

This diagram has been worked out by a rule given in the "Home Study Magazine," which says that

$$C = \frac{3.1416}{2}(D + d)\left\{1 + \tfrac{1}{4}\left(\frac{D - d}{D + d}\right)^2\right\}$$

C = circumference.
D = major diameter.
d = minor diameter.

This looks rather formidable, and is rather long; but let it once be figured out and plotted on a diagram and it is only a peculiar curved line.

Take the second example given with $D = 8$ and $d = 2.5$, then the rule works out $C = 17.5$, which is fairly well approximated by the 17.55 from the diagram.

Some other authorities give other rules.

Nystrom says

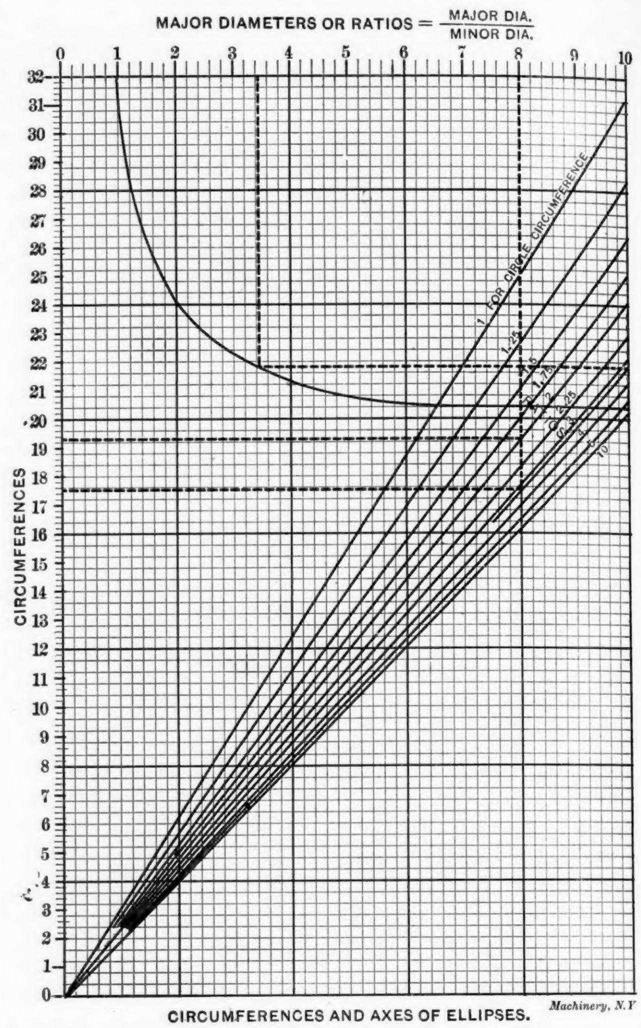
$$C = 2\sqrt{D^2 + 1.4674\,d^2}$$

and while this is shorter, it is also short in the result, as it gives only 17.1 in the special case used.

Molesworth makes a stab with a great big bowie that looks like this

$$C = \frac{\pi}{2}\left\{\sqrt{\frac{D^2 + d^2}{2}} + \frac{D + d}{2}\right\} + 0.1039\,(D - d)$$

and comes out 18.001. That is what he calls an approximation. Now while Nystrom might make a man feel that he probably could keep his waist belt tightened up a notch, Molesworth certainly does not believe that "enough is as good as a feast," but wants to kill by indigestion; at any rate he would be exceedingly



To find circumference when slant for ratio is inscribed. Given major diameter, 8 inches, and minor diameter, 4 inches; then ratio equals 2. Trace major diameter 8 inches down to slant 2, then across to vertical scale and read circumference, 19.35 inches.

When no slant is inscribed. Major diameter, 8 inches; minor, 2.5; ratio, 8-2.5 or 3.2. Trace 3.2 down to curve, across to right hand edge; from intersection lay in slant toward O. Proceeding as above gives circumference, 17.55 inches.

likely to kill one's job if the boss's eagle eye lit on the botched resultant from an implicit trust in Molesworth.

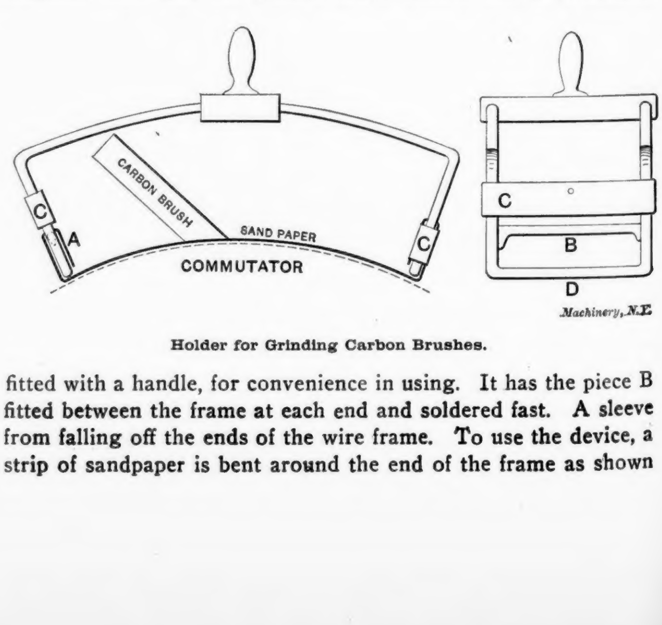
HENRY HESS.

* * *

RIG FOR GRINDING CARBON BRUSHES.

Editor MACHINERY:

The accompanying sketch shows a holder that I made for sandpapering the carbon brushes of dynamos or motors to fit the arc of the commutator. The holder is made of stiff wire ¼" in diameter, bent into the general shape shown, and is preferably



Holder for Grinding Carbon Brushes.

fitted with a handle, for convenience in using. It has the piece B fitted between the frame at each end and soldered fast. A sleeve from falling off the ends of the wire frame. To use the device, a strip of sandpaper is bent around the end of the frame as shown

at A and the sleeve C pushed down to hold it in position. The sandpaper is then passed under the brush so that the abrasive side is presented to it and then bent around the other end of the frame and secured by the holder as in the first instance. Now, by grasping the handle (or the frame, if a handle is not provided) with the sandpaper pressed down to the commutator, the brush can be quickly and easily ground to the correct shape, by working the rig back and forth. WM. W. COWLES.

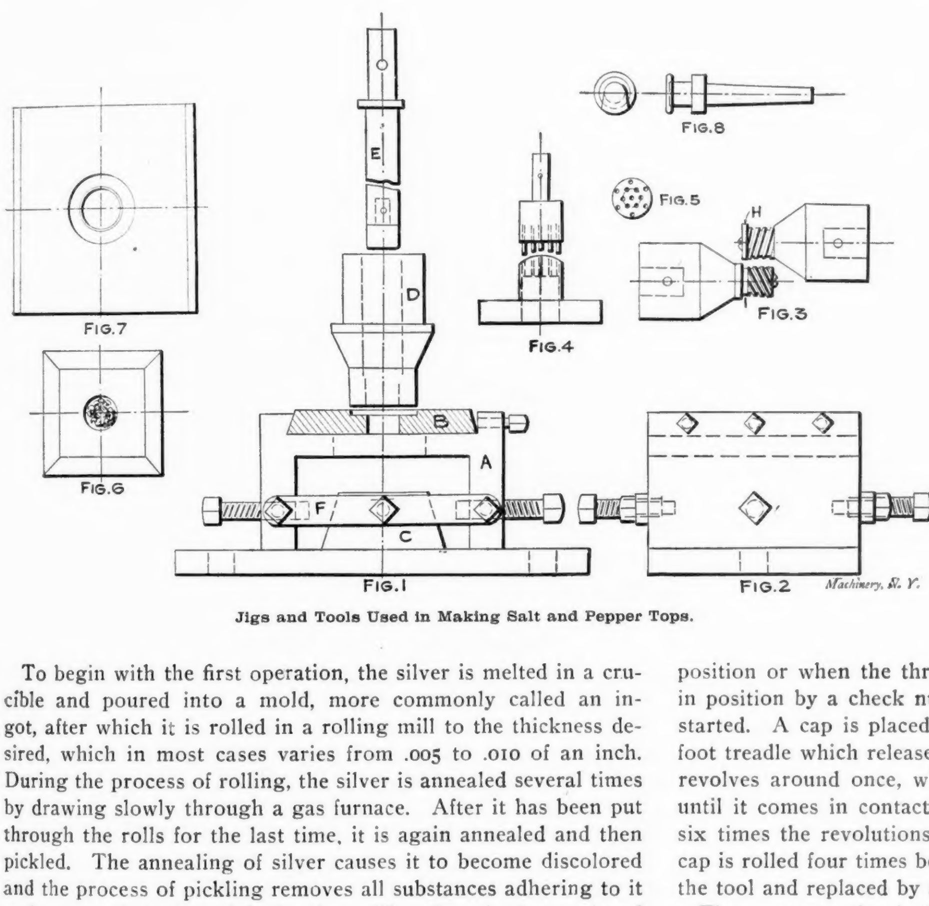
Torrington, Conn.

* * *

SALT AND PEPPER SHAKER CAPS.

Editor MACHINERY:

How many persons in using a salt or pepper shaker stop to think how the caps are manufactured, the stock used in nearly all cases being sterling silver. As I have never come across an article on this particular subject, I will endeavor to give the readers of MACHINERY a description of the art of making these caps and also of the tools used in their manufacture. I was employed in a shop near New York whose business was composed largely of the manufacturing of novelties of silver and gold plate, the most prominent article being salt and pepper caps which were sold to outside parties, placed by them on the bottles and put on the market.



Jigs and Tools Used in Making Salt and Pepper Tops.

To begin with the first operation, the silver is melted in a crucible and poured into a mold, more commonly called an ingot, after which it is rolled in a rolling mill to the thickness desired, which in most cases varies from .005 to .010 of an inch. During the process of rolling, the silver is annealed several times by drawing slowly through a gas furnace. After it has been put through the rolls for the last time, it is again annealed and then pickled. The annealing of silver causes it to become discolored and the process of pickling removes all substances adhering to it and returns it to its original color. The silver is then stripped to the proper width by rolling through a machine termed shears.

The next operation practically comprises three operations: Cutting, drawing and striking the figure on the top of the cap. The tools used for this work are shown in Fig. 1, in their relative positions as they go into the press. The press is called a double-acting press, owing to the fact that it has an outside or cutting plunger and an inside or drawing plunger, the outside plunger cutting the stock and the inside one (which works through the outer plunger) drawing the stock into the form of a cup. A, Fig. 1, is the holder which is bolted to the bed of the press. The holder contains the cutting and drawing die B and the engraved die C which strikes the figure on the top. D is the cutting plunger which fits the large part of the hole in die B which cuts out the blank for drawing. E is the drawing plunger which fits the small part of the hole in die B, allowing space for the stock to pass through. The holder is made of cast iron, set-screwed to hold the dies as shown in Fig. 1, an end view being shown in Fig. 2. Fig. 1 represents a strip of iron bolted to each side of the holder, one end having a slotted hole from which die C can easily be removed by slackening the screws and raising one end. When in use the strap is clamped by the screw at each end, while the screw in the center clamps the striking die to the bottom of the holder. Fig. 7 shows the cutting and drawing die and Fig. 6 the engraved or striking die.

Now comes the operation of spinning, which is done by placing a hardwood block on the spindle of a speed lathe and turning a recess in the end the form of the cap that is to be spun. As there are a number of sizes, styles and figures, there is a separate block for every one. Having turned a recess in the block, a piece of sheet brass, with the same form and figure stamped into it as those on the caps to be spun is placed in the recess and the corners are turned and tacked on the sides of the block. This is called a jacket, and a jacket with the block is termed a chuck. A tool to hold the caps in the chuck is shown in Fig 8. This tool is used as an ordinary lathe center, one end being fitted in the center hole of the footstock, the opposite end being turned to the shape like that of the cap to be spun. There being one or more beads on nearly all of the caps, the center has to be formed the same shape. If it were round, the caps could not be removed after the spinning had been completed. To overcome this obstacle, the back of the center is turned off just enough to allow the cap to be pressed forward and slide over the top of the beads and drop off.

The next operation is to thread the caps as, in nearly all cases, they screw on at the bottom. This threading is done on a machine built for that work and which contains two spindles, one directly above the other and geared to travel in the same direction, the upper spindle being in a movable arm which is raised and lowered by a cam from the back of the machine. This arm has an adjusting screw to allow for the adjustment of the top tool to the various sizes of caps. These tools are shown in Fig. 3. The bottom tool or the one on the stationary spindle has a right-hand thread cut on it, the top one a left-hand thread. A recess, I, Fig. 3, is turned in the bottom to allow the cutter H on the top tool to cut the caps the desired length. When in position or when the threads properly mesh, the tools are held in position by a check nut. The tools once set, the machine is started. A cap is placed on the lower tool arm; by pressing a foot treadle which releases a clutch, the shaft with the cam on it revolves around once, which action raises the movable spindle until it comes in contact with the cap. These spindles revolve six times the revolutions of the cam shaft by which means the cap is rolled four times before it is released. It is then taken off the tool and replaced by another without stopping the machine.

The next operation is that of piercing the holes in the top of the cap, which is accomplished by using the tool shown in Fig. 4. This is simply a cutter and plunger, the cutter being made of one piece of square steel and the upper end turned the exact size and form of the cap in connection with which it is to be used. It is then counterbored from the bottom as shown by the dotted lines and the small holes for the piercing are then drilled and slightly tapered from the back to allow the piercings to fall out. The cutter is then hardened, which brings our attention to the plunger which is made as follows: A piece of steel is turned with a shank that fits a foot-press this being the machine used for that work. The body of the plunger is turned large enough to allow the counterboring of a hole in the end the size of the cutter. It is now ready for the piercers which are made of Stubbs steel wire cut the desired lengths. The wire being the right length, no turning or fitting is necessary. One piece is placed into each hole in the cutter, each piece being forced into the cutter a given length. As the top of the cutter is irregular in shape, it allows all the piercers to do this work at the same time. Having the

wire in place, the opposite ends are filled the same length on the bottom of the hole counterbored in the plunger. The plunger is then placed in a holder, with the counterbored end standing upright; the cutter, with the piercers remaining in their respective positions, is placed on the plunger, the piercers extending into the hole. Lead is now poured into the hole till it is filled and this, cooling gradually, holds the piercers firmly in place. When the piercing is completed, the caps are taken to the polishing room and the inside is scratch-brushed with a wire wheel. Then the caps are polished and washed and are now ready for shipment to be placed upon the bottles that adorn our tables.

A. F. Notroh.

* * *

BLUE PRINTING APPARATUS.

Editor Machinery:

After moving into new quarters at the works where the writer was once employed, it was found necessary to design and build a frame or apparatus for exposing blue print paper and the tracing to the sunlight.

The idea of a frame holding the glass and laid on a padded platform on wheels and allowed to roll on a track through an open window was the first and simplest thought of, but floor space was too valuable to permit of such an arrangement. Then, since some sort of folding frame had to be used, the one shown in Fig. 1 was studied on, but the conclusion was reached that it would be more expensive and heavier than necessary. The matter gradually reverted to the first idea, but with the addition of some means to fold it so as to occupy as little space as possible. The results of our thoughts on the subject prove a very neat arrangement.

The two views, Figs. 2 and 3, show a rolling frame made to be hooked to the portion of the track inside the room, and the track is hinged to the window casing so that by removing a support, the whole can be lowered against the wall. It was found that by allowing 1" around the glass for frame, a 24" x 30" glass could be used. The frame and platform were built to suit these dimensions, cotton and cloth being used to form the pad. The frame was hinged to the rear edge of the platform and the weight of the glass was sufficient to hold the paper and tracing secure. The track was made of 1" angle iron, the ends curved up with a "drop" to keep the carriage or platform from rolling while changing prints, and the section of track outside the room was set at a slight incline, with the outer ends turned up to avoid accidents. The track inside the room had holes in the "drop" ends for the reception of the legs, which were shaped like Fig. 4. There was enough spring in the legs to permit them being put in and taken out.

By hooking the track to the bottom of the padded platform and removing the legs, the whole could be let down against the side of the wall under the window casing, the hinges on the glass frame preventing it from sliding off. Notches were cut in the window sash to fit over the track that ran outside and that section was supported rigidly to the outside of the house.

By the side of the frame in the room was a zinc lined tank, made to be raised and lowered the same as the frame, and when in use it occupied the same space from the wall as the frame, and about the same when dropped down. The tank had a plate on the bottom threaded for a 3/4" gas pipe which was used for the leg, and a pipe was used to empty the water, both being removed when ready to let down. A movable frame with cords and clips or clothespins was suspended over the tank, so that the prints when washed could be hung up and the water drip back in the tank. When not in use the legs and pipe were placed in a corner, back of the case for drawings, and the frame with the pins was let down against the wall by a supporting string.

Taken as a whole, it was a very compact and simple apparatus and was of greatest convenience, since it could be put in place in a moment. The writer gives the idea to any who may be so situated as to need such an arrangement.

Birmingham, Ala. W. D. Browning.

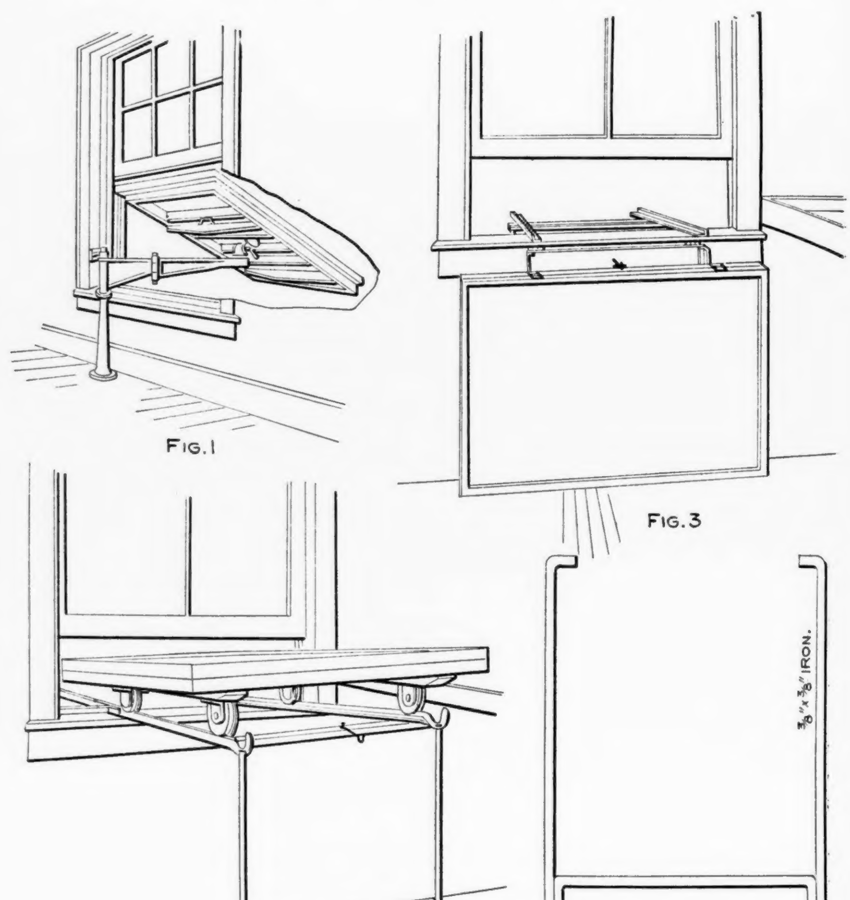
* * *

A TEXAS METHOD OF FIXING PISTON VALVES.

Editor Machinery:

I had a little experience recently that may entertain and instruct some of the younger machinists, especially those who were raised in country towns and who served their time in country shops as has been my "doom" in life.

About two years ago I had to fit a solid piston valve and guarantee it to be tight and satisfactory to the sawmill man for whom it was done. I had no reamers to ream out the valve chamber, so I bored it out the best I could and then turned the valve to fit. I spent about two days grinding, filing and polishing with emery cloth before I could get it into working shape. After all my pains I thought that it was a fine fit, but it was not, although the sawmill man paid for the job just the same. I had no automatic grinding machine or lapping apparatus as you eastern mechanics have, but had to depend entirely on "elbow grease."



Illustrating Blue Printing Frame.

A few days ago I had a similar valve to fit, which was 3½" in diameter for an Armington & Sims engine, and decided to try a different method. I bored out the valve chamber as smoothly as possible and turned the new valve to a light driving fit. After getting everything ready, a few pieces of oil-soaked waste were collected and put in and around the valve chamber and fired. After the chamber was quite well warmed up, I thrust the valve into the chamber with a coating of fine crushed steel and oil. It was turned and worked back and forth quickly to prevent sticking and after a few moments removed and wiped off. After repeating the operation, I found, to my surprise, that good

results were being obtained and very quickly. The job, when completed, made me feel so proud that I thought that possibly some MACHINERY readers might be interested in the "kink."

San Antonio, Texas. H. WEIERHAUSER.

* * *

BORING A ROLL UNDER DIFFICULTIES.

Editor MACHINERY:

I have been a constant reader of MACHINERY for over three years and have received through its columns many inspirations by which I have been better able to overcome many obstacles that have confronted me in the duties as foreman of a machine shop in that time. Believing it is better to give than to receive, I am after the blessing attached to giving, and will tell your readers how we got out of a very awkward predicament in which we found ourselves a short time ago in our factory, hoping it may prove of value to some of them.

By some mishap a 72" x 26" chilled roll (weighing about 6,500 pounds), ordered to replace another, was shipped to us without being chambered out on the ends to receive the stuffing box and gland for the steam and cold water pipes which are used for heating or cooling the roll when necessary. Well, I called John (and by the way that same John is the best man I ever saw for patching up a breakdown or working out of a scrape like the one we were in), and we went out into the mill to look the ground over. Then we went back to the shop and hunted up two angle irons, one with 18" faces and one with 12" faces, a compound slide rest and tool post from a 48" lathe, two heavy bars of machinery steel with bolts, straps and C clamps. The bars of steel were placed across the shaft pit and bolted to the foundation plates. The 18" angle iron was then placed upon them with one face toward the roll to be bored. With the C clamps, the second angle iron was fastened to the first with one face in a horizontal position, and then the slide-rest was placed on this and made fast. This made our temporary boring machine, which is shown in the accompanying illustration. A piece of 1½-inch square steel was then cut to a convenient length, and a ¾-inch hole was drilled through it near one end for the cutters to be used. A setscrew hole was also drilled from the top to hold the cutter in position. Three double end cutters were used, made of ¾-inch round, self-hardened steel, to lengths that would divide up the stock to be removed (which was about 1 inch on a side and 4 inches deep), into equal cuts. The metal of the roll was so hard that turpentine had to be used and with the last cutter we had to take advantage of the noon hour and run the power at about half speed.

There was no lathe in our shop large enougn to handle this roll and if we had been compelled to ship it back to the maker to be bored, it would have cost the company not less than $50, besides, what is of more consequence, about three weeks' time. It took about eleven hours to complete the job, so we estimated that we saved our salary for that day at least.

RUB. BERNECK.

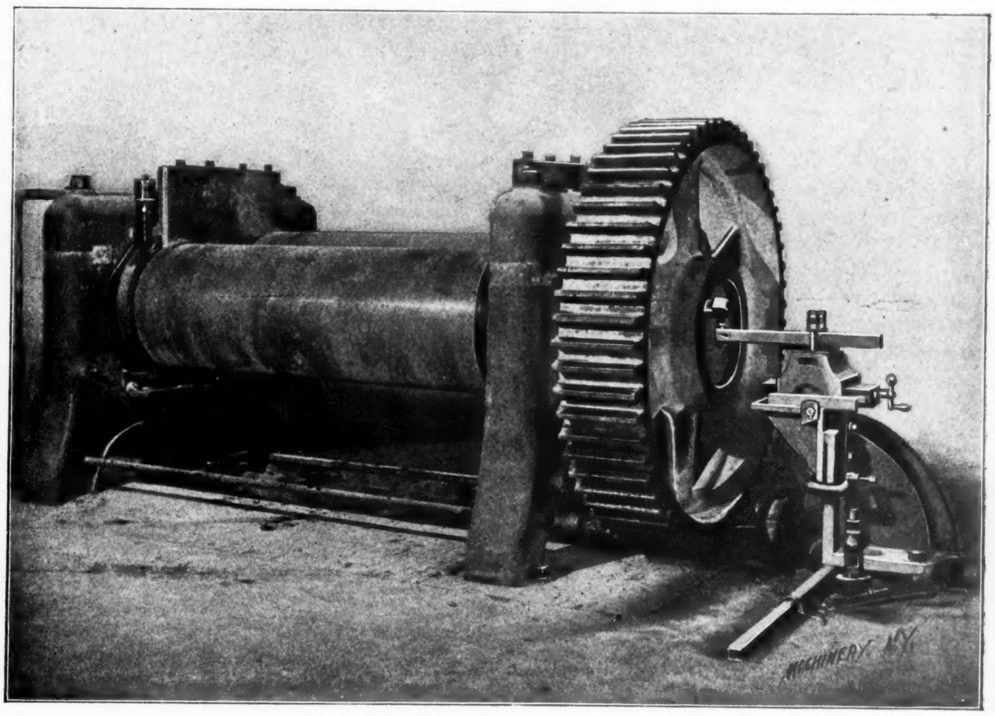
* * *

SOME NOTES FROM PHILADELPHIA—USING HARTNESS TOOL-HOLDERS IN ENGINE LATHES, ETC.

Editor MACHINERY:

Recently, while in Philadelphia, I spent a very profitable quarter-day in the shops of Bement, Miles & Co. looking at the various new tools in process of construction.

Having been quite familiar with the machine tools made by this firm, I was prepared to find careful and painstaking methods followed in their manufacture, and in this expectation I was not in the least disappointed. The scraping of the flat working surfaces of machine tools, which appears so fine in the product of too many tool builders but which is often of not much practical value beyond that it removes the tool marks, is here followed as a means of not only making the flat surfaces smooth and well finished but also uniformly flat and true. The making of accurate flat surfaces for the heavy housings of planers, lathe shears, cross-rails, etc., is a problem not easy of solution. Heavy straight-edges or surface-plates are used for testing when "spotting" down the inequalities left by the planer tool, but when a straight-edge 12 or 14 feet long and 15 inches square in cross-section is used for the work, the difficulties are somewhat increased, as such a mass of metal has necessarily to be handled by a crane and its own weight is enough to slightly deflect it from truth when only supported by its ends. To add to the difficulties of using such large surface-plates, the slight differences in temperature that may easily exist between two opposite sides, make them totally unreliable unless care and judgment are exercised in their use. However, by the use of these straight-



Photograph of Rolls Showing Arrangement of Boring Tool.

edges in conjunction with accurate spirit levels, flat working surfaces are probably made as nearly accurate in this shop as in any other in the country, but to attain the result, time and the services of skilled workmen are absolutely necessary.

Among the notable tools building, I noticed some of the parts of a huge crank lathe for the Westinghouse Machine Co. of Pittsburg. I was informed that this lathe is the third one of the class and size that has been built in these shops, the other two being for the Carnegie Steel Co., of Pittsburg, and the Midvale Steel Co., of Nicetown. The swing of this lathe is 125" and its total weight is not far from 100 tons. The spindle has 21 speeds and is of cast iron running in cast iron boxes. The steady-rest was being drilled for the bolts holding the jaws while I was there, and it was standing erect. Its height was not far from 8' and was estimated to weigh not far from seven tons although I think the estimate was too high. At any rate it would be quite a respectable piece of work for the average shop to turn out.

A planer is running in this shop which has been in service nearly forty years and is still doing good work although quite noisy on the return travel. It has been widened out so as to have a capacity of 10' in width but when compared to the planers of an equal capacity, built at a recent date, it of course appears very light and weak. This planer was run night and day, during the Rebellion, on contract work for the U. S. Govern-

ment and it is said that on it was earned the foundation of the Bement fortune as prices were received for its services that would now seem enormous.

The foreman of the bolt department has worked out a simple and effective way of making his old engine lathes do as much work in turning bolts as is possible on the Jones & Lamson lathes, of which there are six in his department. The scheme consists simply of using a Hartness tool-holder on the carriage of the engine lathe and locking it so as to be central with the axis of the lathe. The cross-slide of a lathe to be changed over, is removed and the top of it planed off to allow the tool-holder to set at the correct height. It is then bolted fast to the slide and the cross-feed screw removed, the slide being fastened in position by the gib screws. With these old lathes, a boy is able to easily turn 100 6" x 1½" bolts in ten hours and face the under side of the heads. Of course no other operation, such as threading or chamfering the heads, is attempted.

The threading of the bolts used in the construction of the machine tools here built, is required to be as nearly concentric with the bolt as if threaded on centers in an engine lathe. To get this accuracy there has evidently been some trouble, and as the foreman has insisted on there being no eccentricity in the threading, a guide has been attached to the face of the Hartness die which starts the thread exactly square with the axis of the bolt. I have never seen this device used before but am inclined to think that it is a good thing where extreme accuracy is required. The guide does not interfere with threading close to a shoulder as it can be opened after the thread is well started and allowed to hang down out of the way.

Undoubtedly, some machinists and manufacturers are under the impression that the quick change devices now applied to a number of engine lathes for accomplishing the change of lead for any screw by the simple shifting of a lever, is a rather new idea. In the bolt department I saw an old lathe, built over twenty-five years ago, which has this feature, but which is not arranged as neatly and compactly as the gear boxes seen on the modern lathes; neither does it have as great a range, the total number of threads that can be cut by shifting the lever being six or eight. The idea, however, is exactly the same as that worked out in the modern lathes and which is, I am informed, the subject of a suit for infringement. R. P. PERRY.

Hoboken, N. J.

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CHUCK FOR THIN WORK.

Editor MACHINERY:

The chuck described in the March issue of MACHINERY, for boring gears, brings to my mind a chuck which I made some time ago for squaring up some cast-steel discs. These discs were punchings 4" in diameter and 1-8" thick and, as such thin pieces cannot be held securely in an ordinary chuck or on an arbor, they were machined in a special chuck made for the job as follows:

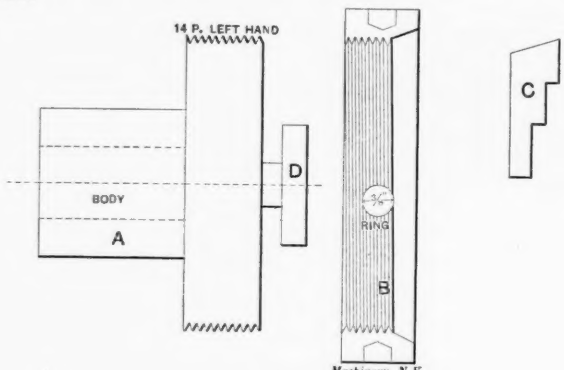

Fig. 1.

The chuck was made entirely of cast iron—body, jaws and all. As the cast iron jaws are easily made, the cost is but little to have a number of sets for different sizes of work. Another advantage of the cast iron jaws is that they are easily trued up. The body of the chuck was made from a casting shaped like A in Fig. 1, which was internally threaded to fit the nose of the lathe spindle. The hub or boss D was turned and a left-hand thread of 14 P. was cut on the large diameter. The pitch of the thread must be left-hand as the jaws have a tendency to turn the ring in a right-hand direction when under the pressure of the tool, and if the ring were threaded right-handed, it would tend to unscrew and loosen the jaws. The ring B was tapered on the inside for a short distance from one side for the jaws C, C, C, etc. These jaws were made from a cast iron disc or plate about 3-4" thick and were tapered on the outer edge to fit the bevel of the ring B. The steps were then cut in the face of the disc to fit the size of piece to be held and then it was still further faced off to fit the recess behind the hub, or boss D, rather snugly. The shoulder outside of this hub was sufficiently relieved to prevent the jaws from tightening on the hub when the work was being chucked. After all this work was finished, the disc was cut into six pieces.

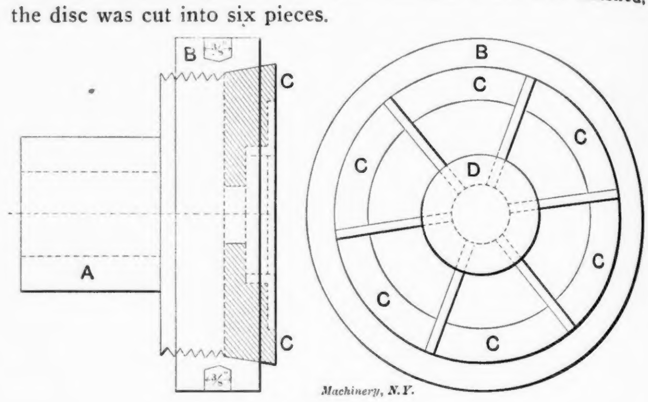

Fig. 2.

The chuck is assembled, as shown in Fig 2, by putting the jaws in place behind the hub and then screwing on the ring B which holds them from falling out and which also forces them against the piece to be held. Four holes are drilled in the periphery of the ring to allow the use of a 3-8" pin as a chuck wrench.

The punchings mentioned were turned up in this chuck and firmly held. The chuck was also used to hold them for grinding after being hardened. One advantage of this chuck over the step chuck, which should be mentioned, is that work can be faced clear to the edge, which is often impossible with the latter. W. A. STINSON.

Dorchester, Mass.

* * *

A STRANGELY FRACTURED CHISEL.

Editor MACHINERY:

I send you herewith two photographs showing a break or split in a handled chisel, that is something of a curiosity. The chisel was made from Crescent steel and has been in use at the boiler shop of Wickes Bros., in this city, about two years. The fracture, as shown in Fig. 2, extends from the head down to the edge and parts the chisel in two so nicely that the cutting edge was divided nearly two-thirds the width. For the remainder of the distance, the fracture did not extend above the ground part. The width of the cutting edge is about 1 5-16" and the length from the edge to the head is 5¼". A. M. BARBER.

Saginaw, Mich.

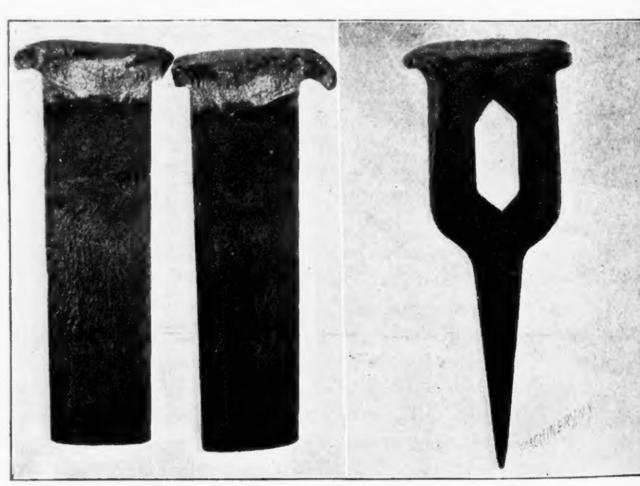

Fig. 1. Fig. 2.

[Apropos of this instance, it may be remarked that some blacksmiths temper the heads of their chisels, especially those for cold cutting. The results, when the tempering is properly done, are said to be quite satisfactory, as there is no battering or splitting ,and thus the head is always kept true and the number of broken handles, consequent to "glancing" blows from the helper's sledge, is lessened. The heads are drawn down to about the same hardness or slightly less than that found best for a hammer tace.—Editor.

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A FEW KINKS FOR THE DRAFTSMAN.

Editor MACHINERY:

One might think that the drafting room of to-day, with all its equipments, improved methods, etc, as well as the modern tools for the draftsman, had reached almost a state of perfection; yet in spite of these, we keep finding new tools and better methods, as well as many new ideas that add something to the general advance. Three or four of these helps have caused sufficient interest on my part to note the same and as I have never seen them published, I venture to give them to the readers of MACHINERY, trusting they may be of some interest.

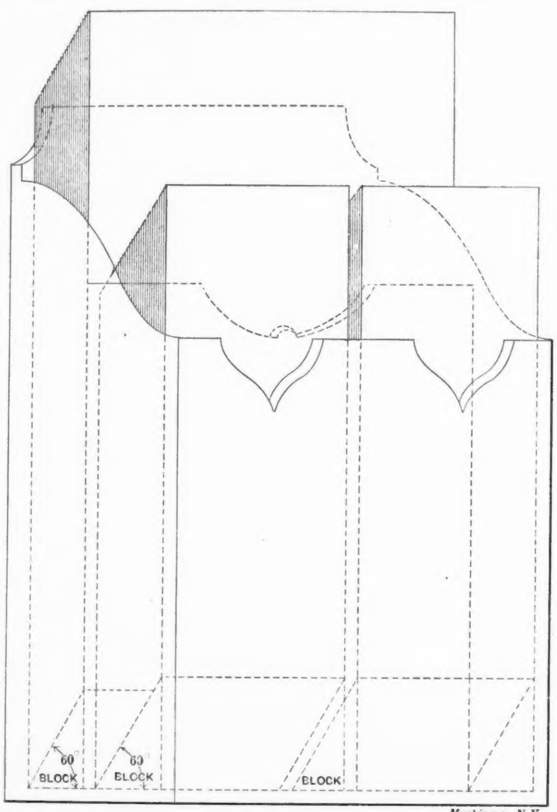

Fig. 1.

I suppose most draftsmen have a little box with three or four compartments for different sized note paper, and a good many, like my own, either stand on the table or are fastened to the wall. The compartments are open at the top and are arranged so that the larger sheets are at the back. When one is in a hurry, he will reach for a sheet and most likely get several; two or

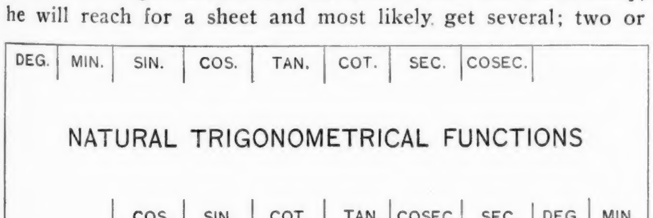

Fig. 2.

three attempts may bring success or he may fail and try again, wetting the tip of his finger. Even this may prove unsuccessful and if so, he is likely to become a little impatient, get on his feet and use both hands or throw the sheets on the table to be replaced when he has more time, or, most likely, throw them in the waste paper basket. Now, if he will have a strip of wood sawed triangular shape, Fig. 1, having the angular side for the paper to rest upon not less than 45 degrees, preferably 60 degrees, with the base; cut it in pieces just long enough to fit the openings, place the blocks in the paper holder with the high side to the front and then put in the note paper, he will have a holder similar to the one shown in Fig. 1. The top edges of the paper will be on the same angle as the block. I think he will feel well paid for his trouble in the ease with which he can get one sheet when he wants it.

Did you ever try to draw with your triangle or straight edge on cardboard or on a surface that was slightly rounding and have them slip out of place? If you will paste three or four pieces of fine sand paper, about the size of a dime, on your triangle or straight edge, you will find that it will stay where you hold it.

In using tables of trigonometric functions, logarithms and others, you will find a help in the following: Take a card the same width as the table and copy on the upper edge the heading at the top and on the lower edge the lower heading. For instance, for the trigonometric table you will have a card like Fig. 2. Move this card down the table until you come to the number or degrees and minutes wanted and you have the heading where you can see it, instead of looking at the top of the table to find your column of sines or tangents and then following down, at the same time keeping your finger on the degrees or number, (whichever you happen to have in finding the other.) With such a card one can find what he wants quickly and with less chance of a mistake.

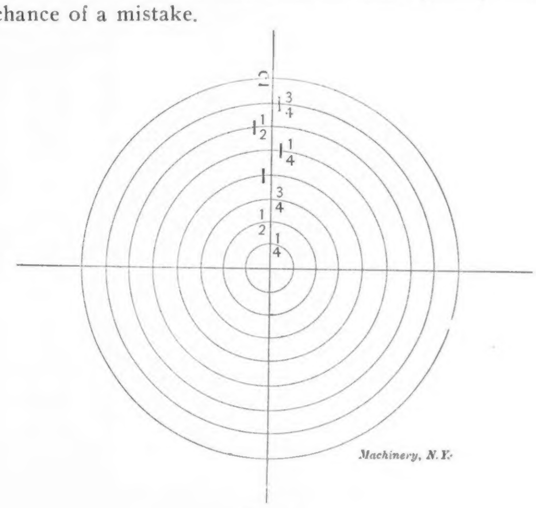

Fig. 3.

Another handy card is one having circles carefully laid out in sizes from 1-16″ to 2″ in diameter, arranged in groups like the drawing, the smaller ones within the larger, and with the sizes selected so as to have a space between them large enough for the figures that denote the sizes, as shown in Fig. 3. Shellac the card so that it will keep better and stand cleaning. When a certain size circle is wanted, you have only to set your compass to the size desired, and you can usually get a better setting than on a scale, in the same time. On the other side of the card you can draw the different sizes of hexagon heads for bolts, screws, etc., and when you have occasion to draw one, the radii wanted for the rounded top will be laid out ready for you to copy.

Providence, R. I. EDWIN C. THURSTON.

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ABOUT THE PLANER TOOL HOLDER.

Editor MACHINERY:

In the January number of MACHINERY, "A New Planer Tool" is illustrated and described, as manufactured by the Armstrong Tool Co.

I wish to state that the tool described has been in general use in the machine shop of the Pennsylvania Steel Co., at Steelton, since February 7, 1881, and was made by the writer, the only difference being that we did not use the grooves round the edge of the bar to hold the tool from slipping around, as this feature has never been found necessary. On the contrary, the holder is better without the grooves, as in adjusting a broad square nosed tool for finishing, it can be moved around until the exact position is reached and then screwed fast. The object in view at that time was to cut a number of irregular surfaces on

the planer smoothly, and the ordinary "goose neck" tool required too much steel and labor to make a number of them. In consequence, a square iron bar was used in the tool holder, with a hole drilled through the lower end, and a small steel cutter of the shape desired was bolted to the back of it. This proved so satisfactory in increased work and economy of tool steel, that the principle of using a small piece of tool steel in a holder (instead of a large solid tool), was adopted at once, and has continued in use since that date, and as before stated, is the same as the one illustrated. Reference to the "American Machinist" of February 26th and April 16th, 1881, will confirm the foregoing statement. GEO. H. ROBERTS.

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THE THREAD PROBLEM AGAIN.

Editor MACHINERY:

Since writing the letter giving the thread problem published in the January issue, I have solved the difficulty myself but have waited to see what the readers of MACHINERY had to say about it. The answer given by Mr. F. T. Miller is a correct solution of the trouble. I found the error by marking on the ways for each advance of the tool for a total of 8 threads and when I had finished, I found an advance of only 7/8 inches instead of one inch which should have been the case. The difference shows a loss of advance which, when compared with the number of threads and the lead, accounts for the difficulty I met. I thank the readers of MACHINERY for the interest manifested in this problem.

Poughkeepsie, N. Y. E. O. JOHNSON.

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OBITUARY.

Mr. Henry R. Hazlehurst, of the Murray & Hazlehurst Company, manufacturers of marine engines, etc., established in 1850, died on February 21, at Baltimore, Md.

Mr. Addison C. Rand, M. Am. Soc. C. E., president of the Rand Drill Company, died at his home in New York city on March 9. Mr. Rand was born in Westfield, Mass., in 1841. He was one of the founders and for some time treasurer of the Engineers' Club of New York city and was a member of the American Institute of Mining Engineers and of the American Society of Civil Engineers. He was a director of the Ninth National Bank of New York, and of the Laflin & Rand Powder Company.

Charles H. Coster, a member of the firm of J. Pierpont Morgan & Co., died in New York on March 13. He was also director of a number of railroad companies.

H. D. Richards, general foreman of the Bundy Manufacturing Company, died recently at Binghampton, N. Y., aged 37 years.

William C. Ferguson, superintendent for the Westinghouse Air Brake Company, died on March 3, at Pittsburg, Pa.

Gottfried Daimler, founder of the Daimler Motor Company, Cannstatt, Germany, died in that city on the 6th inst., aged 66 years.

William Wallace Rogers, a member of the firm of Woodward & Rogers, machinists and tool-makers, Hartford, Conn., died in that city on March 1. Mr. Rogers came to this country from Paisley, Scotland, and was first employed by the Pratt & Whitney Company.

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FRESH FROM THE PRESS.

Kinematics of Machinery, by Prof. John H. Barr, M.S., M.M.E., of Sibley College, Cornell University. Published by John Wiley & Sons, New York. 252 pages, illustrated. Price $2.50.

This is called by the author a "brief treatise on constrained motions of machine parts." The book is intended for a short general course in kinematics and gearing for students in engineering colleges. It treats of subjects generally included in such a course, touching upon elements only, yet giving sufficient information to enable one to lay a good foundation for future work. The chapters on cams, linkwork, belts, ropes and chains, and trains of mechanism are presented in about the same manner as similar chapters in other works, but the three introductory chapters of the book, which take in all 78 pages, give a very full and clear course in pure kinematics, developed by Reuleaux methods. These chapters appear to be the distinguishing characteristic of the book.

There is a chapter upon gearing, but this touches only upon the elements. The author states that he does not deem it necessary to give more than a statement of fundamental principles since there are so many books in which the subject of gear teeth is exhaustively treated.

This book, like many of the works produced by those engaged in instructing, is the outcome of several years' experience in the class room and has been gradually developed from notes prepared for students' use. It is, therefore, to be expected that the book will be found well adapted to class-room work and will be free from the defects of books that have not been tried in the class-room. As a logical and concise treatment of pure mechanism, or kinematics—sometimes called the geometry of machinery—we think Prof. Barr's work is one of the best presentations that we have seen.

It may be added that while a course in mechanism, treated as a science of pure motion, is of undoubted utility for an engineering student, no student can become a successful draftsman until he understands the applications of its principles to practical constructive problems. Such a course, therefore, needs to be supplemented by drawing-room practice and by sketches and drawings, or by the examination of actual machine parts, to enable the student to become familiar with the application of its principles. Our only criticism of Prof. Barr's work is one common to most works of this nature and is to the effect that it would be of great help to students if he were to add enough sketches to those given to show clearly some of the applications of the principles to actual practice. While such an addition might be contrary to the scope of the work from a scientific standpoint, it would add to its practical value.

Lubrication and Lubricants, by Leonard Archbutt, F. I. C., F. C. S., Chemist to the Midland Railway Co., and R. Mountford Deeley, M. I. Mech. E., F. G. S., Inspector of Motors and Boilers, Midland Ry. Locomotive Department. Published by Chas. Griffin and Co., Lim., London, and J. B. Lippincott Co., Philadelphia. 450 8 vo. pages, illustrated. Price, $5.50.

This is the most complete work that has come to our attention upon the subject of lubrication. There are a few brief chapters upon friction and the theory of lubrication, but the bulk of the work treats of lubricants, their sources, preparation, examination, and uses, going minutely into the various phases of the subject.

As would be expected, much attention is given to the examination of lubricants, the determination of their composition and the detection of different elements, objectionable or otherwise, contained in them. A chapter is devoted to the systematic testing of lubricants by chemical and physical means and one upon mechanical testing. There are two final chapters upon the design and lubrication of bearings and the lubrication of machinery.

The book is written by two men, one of whom is an engineer, and the other a chemist. It therefore treats of lubrication from the standpoints of both the chemist and the engineer and will prove valuable to either. It is doubtful whether the full value of those parts devoted to chemistry can be realized by one who does not possess a knowledge of chemistry, since many of the tests require a knowledge of chemical reactions.

The Steam Engine in Theory and Practice, by William Ripper, Professor of Engineering in the University College of Sheffield. Published by Longmans Green & Co., London and New York. 400 8vo. pages, illustrated. Price $2.50.

Prof. Ripper's elementary text-book on the steam engine, entitled "Steam," has been favorably known as one of the best elementary text-books on that subject for several years and we have therefore examined this more advanced work with unusual interest. It is in substance the notes that Prof. Ripper has given his classes upon steam and the steam engine and so is primarily intended as a text-book. It is, however, essentially a handbook for ready reference upon the steam engine and as such will be found of great convenience by engineers and designers.

The treatment throughout is brief and a great deal of information is condensed into small compass, as would be the case in a note book. There is a short treatment of the essentials of thermodynamics, and the slide valve, indicator and other standard subjects are given a small amount of space. There are several chapters devoted to subjects that are of the greatest importance, but that generally receive but brief mention in books of this character. One of these is upon the reciprocating parts and their effect upon fly-wheel proportions and another is upon balancing the steam engine.

That the book is up to date will be seen by reference to certain of the chapters. For example, under feed-water heaters is explained the effect of drawing the steam for heating the feed water from the receiver of a compound engine; under governors the inertia governor is discussed; the important question of the effects of the cylinder walls upon condensation in the cylinder and the economy of the engine is given space; and the performance and economy of different types of steam engines, superheated steam, the steam jacket, etc., receive attention. For a concise, yet comprehensive treatise, we can highly recommend the book.

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Worms and worm-wheels are usually cut to a certain circular pitch, as it is more convenient than to attempt the accurate conversion of the troublesome factor, 3.1416.

NEW TOOLS OF THE MONTH.

Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.

NEW MULTIPLE SPINDLE DRILL.

The six-spindle multiple drill shown in the accompanying half-tone engraving represents the smallest of a family of four machines of this type which The Bickford Drill and Tool Company, Cincinnati, Ohio, are just placing on the market.

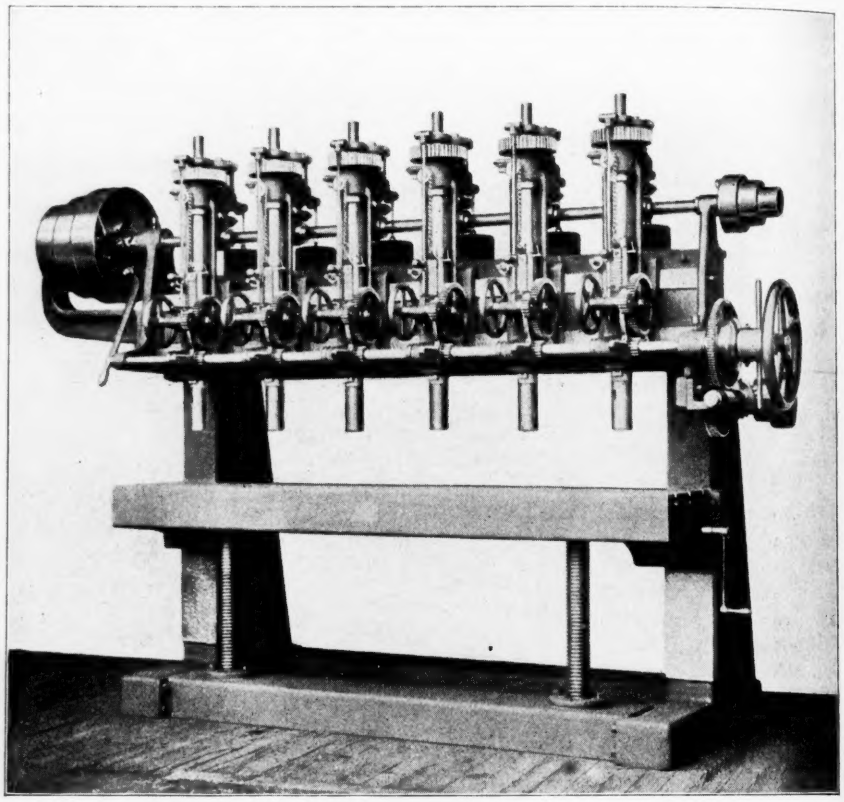
The spindles have six changes of speeds with three changes of feed for each speed, and are provided with both hand and power feed, quick advance and return, and automatic stop.

The heads are composed of the least number of parts consistent with durability and convenience of operation, are adjustable on the rail, and may be used independently or collectively as desired, each head being complete in every particular.

The back gears are located inside of the cone, and are so arranged that they may be instantly engaged, disengaged, or the spindles stopped altogether, by one stroke of a lever. This is a feature that will be found a great convenience.

The rail and table are made in four lengths, ranging from 5 to 11 feet. The 5, 7 and 9-foot tables are adjusted by means of two screws only, while the 11-foot one has three screws, operated in both cases from either end of the machine.

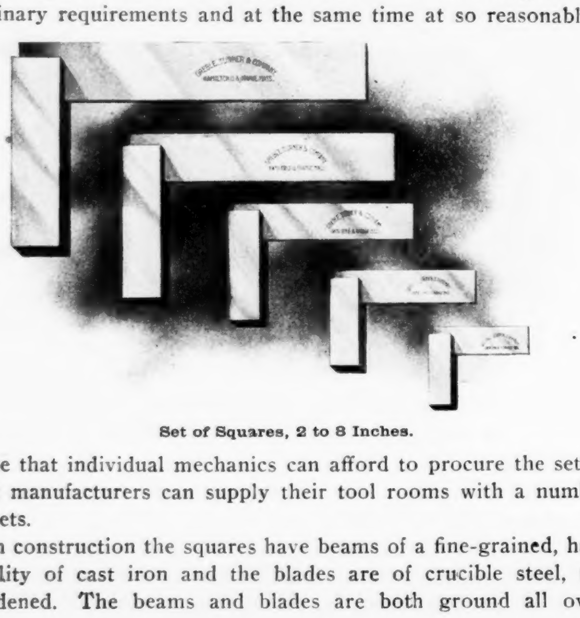
The manufacturers write us that the half-tone shows but one of many styles of table with which the machine is fitted, and that the number of heads and form of housings may be modified to suit the requirements of almost any class of work demanding the use of a tool of this character. They also append a number of the principal dimensions as a guide to its general capacity: Diameter of spindles, least section, 1 9-16". Spindles bored to fit Morse Taper No. 4. Vertical traverse of spindles, 12". Vertical adjustment of table, 18". Maximum distance between the table and spindle, 3". Weight, complete, as shown, 6,850 lbs.



Six-spindle Bickford Drill.

MACHINISTS' SQUARES.

Greble, Turner & Co., Hamilton, Ohio, have placed on the market a set of five try squares for machinists' use, ranging from an 8-inch to a 2-inch square. The object has been to produce a set of squares that should be accurate and satisfactory for all ordinary requirements and at the same time at so reasonable a price that individual mechanics can afford to procure the set or that manufacturers can supply their tool rooms with a number of sets.



Set of Squares, 2 to 8 Inches.

In construction the squares have beams of a fine-grained, hard quality of cast iron and the blades are of crucible steel, not hardened. The beams and blades are both ground all over. The blades are accurately adjusted and held down to their seat in the beam by three nicely fitted taper rivets. In a letter sent us by the manufacturers it is said that it is believed that the squares will wear and retain their squareness for many years, and the fact of their not being hardened makes them less susceptible to changes of temperature or to internal changes than the more expensive hardened squares.

We have had the privilege of examining a set of these squares, and have taken much interest in inspecting them as regards finish and accuracy, because of the low price at which they are sold. They are similar in appearance to the best grade of machinists' squares now on the market. The finish is satisfactory; though less time has evidently been devoted to the final finishing than is given to the best hardened squares, the surfaces are all carefully and evenly ground and look well.

With regard to accuracy, we judge, from a commercial test upon a true surface with the aid of pieces of tissue paper to place between the blades, that they will answer all requirements satisfactorily. The greatest error detected with the blades back to back was less than a thousandth of an inch per foot, divided between the two blades. In testing with one square inside of another, the outer edge of one blade lining with the inner edge of the other, the error in each case was slightly larger, in one instance, as an extreme, reaching, perhaps, 1½ thousandths per foot. The squares are packed in a hardwood case, are warranted by the manufacturers, and seem well adapted to the needs of machinists.

IN BRIEF.

Speed Lathe, 11-inch swing. R. E. Kidder, 35 and 37 Hermon street, Worcester, Mass., has brought out an 11-inch speed lathe with these features: Head and tail spindles of crucible steel; size of hole in spindle, 9/16 in.; front bearing, 1⅜ x 2¾ in.; composition boxes. Size of cone: small section, 2½ in.; large, 6⅝ in.; 1 9/16 in. face. Tail spindle is easily changed from a wheel to a lever feed and vice versa. There is a shelf on the back of bed for tools. The binders for rest and tailstock are convenient and effective.

Multiple Drill. The Langelier Mfg. Co., Providence, R. I., have placed a four-spindle drill on the market which is intended for manufacturing where pieces are to be made in a quantity.

Shaper. A new shaper called the "Stockbridge" shaper is being built for the Niles Tool Works Company, 136 Liberty street, New York. It has an improved crank motion, a down feed and a number of other features peculiar to this machine.